POWER

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ELY C. HUTCHINSON, *Editor*

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Ceremonial

WE PRIDE OURSELVES upon our republican simplicity, upon our lack of form and ritual and ostentation, especially in public places.

But somehow there is something in the soul of man that reacts favorably to stately settings, impressive ceremonies, sounding phrases and the majestic conduct of public occasions.

We have passed from obsequious deference to the divinity that doth hedge a king to regarding the holder of public office as a servant of the people. But that is no reason why we should call him by his first name and begrudge him any manifestation of the distinction due to his high trust.

The processes of administration may be just as efficient and effective if impressively conducted amid appropriate surroundings. The Supreme Court would not arrive at more just and business-like decisions if the judges sat in their shirt sleeves. And their silk gowns are more consonant with the majesty of the ultimate law.

A marriage may be consummated in the dingy office of a magistrate, or a loved one committed to earth with no other formality than a doctor's certificate and a burial permit, at a great saving in time and expense; but there are some occasions which even the plainest of us feel should be marked with some circumstance and ceremony.

Who can resist the inspiration and exaltation invoked by the dim religious atmosphere of a great cathedral, a gorgeous pageant, a magnificent opera or a drama—where all the influences of art and music and eloquence and tradition and age-old usage are combined to arouse emotion.

Must we depend upon these for our heroes and display and get our ideals of courtly splendor and magnificent expression from reproductions of those of other peoples and of other times?

There is more to life than getting things done. Perhaps without letting up the stress on efficiency we might do well to stop spelling it with a capital E and pay more attention to the influences that make men feel as well as to those that make them produce.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

A Step Toward Regional Organization

THE POWER producer is vitally interested in a recently proposed plan to promote economic balance in the United States, an abstract of which appears in this number of *Power*. It is founded upon sound principles, and its consummation should be followed with a healthy growth in industry and in power demand.

The value of community spirit and co-operative action as a means of regional upbuilding needs no brief. The splendid example offered in the success of the New England Council during the past four years is available for any skeptic. The consistent industrial improvement of "United New England" is being paralleled there by a growth in industrial and public utility power that should be inspiring to power producers.

One's broad interest in community welfare and the general prosperity, exclusive of individual concern in the growth of power, is sufficient reason for the support of a plan which has in it the seed of success.

St. Lawrence Development Faces Many Delays

WHEN Governor Roosevelt announced his approval of the water-power bill now before the New York State Legislature, it was hailed as a red-letter day for hydro-electric development in that state. Water power was no longer to be the political football it had been for twenty years, but was to serve homes and industries. Unfortunately, the slowness with which the political mill grinds is only exceeded by the uncertainty of its product. The report of the Governor's acceptance of the proposed bill to take his state's water power out of politics had scarcely been published before the main issue was lost in a forest of political subterfuge.

The bill as drawn gives the Governor the right to appoint a commission, not subject to confirmation by the Senate, to study and report a plan, or plans, for the development of St. Lawrence River power. A plan for state ownership is to be studied first, after which others may be considered. The report is to be submitted to the Governor and the Legislature, the latter having power of approval, rejection or modification. All the elements are here for sinking New York's water powers deeper in the political mire instead of releasing them, the ostensible intent of the bill notwithstanding.

So far as St. Lawrence River power is concerned, it probably will make little difference if it serves political expediency for some time. As explained elsewhere in this number, before the international section of the river can be developed, many complicated questions must be adjusted between the United States and Canada. An immediate settlement of these problems does not appear probable. Even when a treaty has been negotiated between the two countries other obstacles will remain. In the United States the Federal Government exercises control over the structures that may be built in the river. New York State owns the land in the river's bed where the dam must be built, and the riparian rights belong to a private corporation. This is not an inspiring combination for speedy development, were there nothing else in its path.

Economic law must also be considered. As the development is a joint one, it must be favored by both interests before it is likely to be started. A study of the undertaking shows that although it may now be economical for New York State to make the development, this is not so in Ontario.

Much as it is desirable to utilize our water powers, the development of the international section of the St. Lawrence River is likely to be delayed for several years. In the meantime, if New York State settles on a definite water-power policy, a valuable advance will have been made toward achievement of the project.

Emergency Decisions

DOES the good plant operator possess some mysterious "sixth sense" that tells him what to do when things start popping? Some say "yes," but Alex Bailey, superintendent of station operation for the Commonwealth Edison Company says "no." In a recent address, reported last week in *Power*, he branded this idea as a popular myth—and the operating record of Mr. Bailey's plants commands respect for his opinions. "Hunches," said Mr. Bailey, "are frequently wrong; effective action in emergencies is rather the fruit of foresight and forethought."

Mysterious powers cannot explain Chicago's record of twenty-five years without a major shutdown. Careful consideration, months in advance, of all conceivable emergencies, rather than the intuitive actions of some dramatic movie-hero engineers, is the explanation.

Consciously or unconsciously, every competent operator is constantly preparing for the day of trial. He is learning the capabilities and weaknesses of his men,

machines and connections. In mental pigeonholes, ready for instant use, he is setting up a procedure to take care of this or that which may happen some day.

And when trouble develops his task is chiefly one of selection. The action taken almost instantly has, in fact, been long and calmly considered. For that reason—and that reason only—it is generally right.

The man who thinks ahead has another great advantage over the "hunch artist." Knowing where to expect trouble, he guards the weak spots by constant vigilance. By periodic inspection and overhauling he avoids ninety per cent of the possible trouble; he keeps things from happening.

Getting Rid Of the Moisture

AS IS WELL KNOWN, one of the handicaps to the employment of very high steam pressure in condensing plants is the wetness of the steam in the lower stages of the turbine; a condition that is detrimental to efficiency and increases erosion of the blades. This has made necessary the recourse to reheating between high- and low-pressure elements, with either live steam or the gases of combustion.

It is to get away from the complication incident to reheating, as well as to improve the efficiency of the steam cycle, that higher steam temperatures are being viewed favorably. But there is much pioneer work to be done before they become widely accepted. Even with the highest temperatures at present contemplated, the exhaust will contain considerable moisture.

In the meantime, it is worth noting what certain European turbine builders have done toward combating the wet-steam problem. They have adopted the expedient of drawing off the water at each stage, this water being led from stage to stage and finally to the condenser. The results are claimed to be almost as good as reheating, and much less costly.

The limitations of this method—for undoubtedly limitations exist—and a comparison with American practice, would provide a profitable subject for discussion.

The Advantages in Checking Power Costs

"CHEAPER POWER Through Modern Equipment" and "Easier Financing of Equipment Purchases"—These, the third and fourth of *Power's* principles, go hand in hand. Although they have been frequently discussed, they never fail to find basic application in current affairs. This is the test of their fundamental relation to the power field.

It is an unfailing mark of progress that the best machinery or equipment of today is second-best tomorrow. The advances in science in the knowledge of materials to withstand corrosion, high temperatures and pressures; in the design of boilers, turbines and power plant accessories—all have made possible the anomaly of lower unit power costs with increased costs of practically all the components of construction.

As the modern power plant, be it utility or industrial, assumes business domination because of its cheaper power costs, its path is marked with plants that are unable to compete.

Owners troubled with symptoms of their being in the latter class should investigate the economic possibilities of cheaper power through the installation of modern equipment.

This does not necessarily mean entire reconstruction. In most cases modernization can be effectively accomplished by the addition of accessories and appurtenances to existing equipment.

Happily, the problem of financing has been simplified since the business conferences were held in Washington during the last quarter of 1929. There should be no great difficulty now in finding funds for improvements where cheaper power will result.

Owners or operators should realize it is worth while to investigate the earning power of modern appliances, whether their plants be hardly old or decidedly so.

Professional Engineers— Take Heed

"YOUR professional reputation can earn dividends for you."—Under this caption an advertisement recently appeared in an engineering publication in the power field. It tells the reader that a golden opportunity awaits if he will use his professional prestige with his client to sell the advertised device. Thereby, so it is said, the client will be made happy and the professional man will receive a suitable commission without becoming a dealer . . . . "help to close sales and bring you the commissions!"

That the advertisement was in a reputable publication would be unbelievable were it not a fact.

Does the manufacturer really believe in this method of doing business? Does he regard it as a constructive trade builder? Then he is ignorant of the advance of business and professional morals in the past score of years, for he proposes a relation between professional engineer and client long recognized as pernicious and dishonest.

No professional engineer worthy of the title and the confidence of his client will accept the proposal. To do so would directly violate all ethical standards and destroy his self-respect. Moreover, the mere suggestion is sufficient to cause complete loss of confidence in the advertiser and his wares.

This may be hard on the manufacturer, but it is the natural reaction of any reputable professional who really earns his dividends.

New Plant DOUBLES CAPACITY *of Central Heating in Pittsburgh*

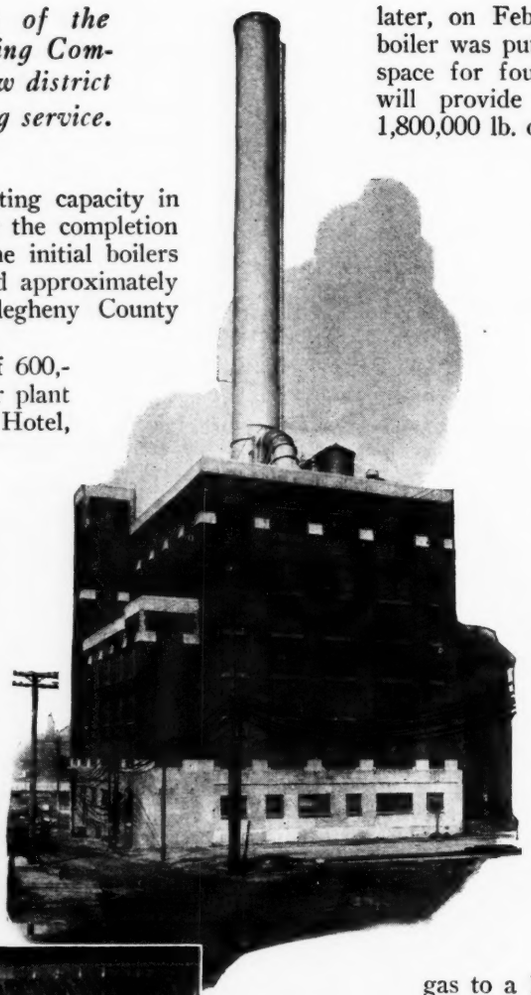
By M. R. Sumner
General Superintendent of Construction
Pittsburgh Branch
Byllesby Engineering & Management Corp.

The Twelfth Street *plant of the Allegheny County Steam Heating Company has lately opened up a new district in Pittsburgh for central heating service.*

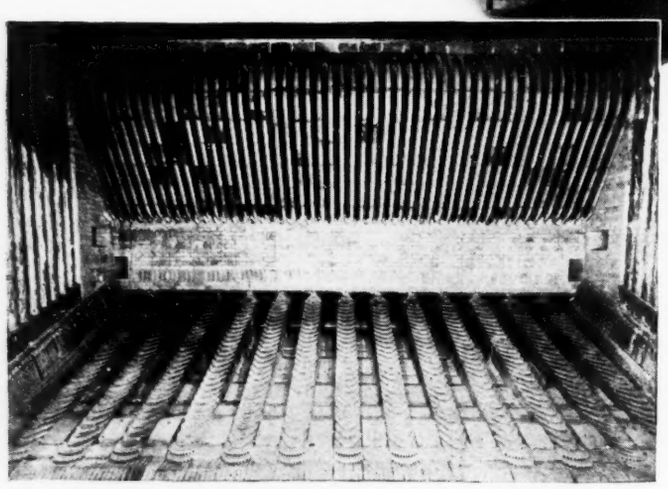
CENTRAL STATION steam heating capacity in Pittsburgh has been increased by the completion of the Twelfth Street plant. The initial boilers were placed in service late in 1928, and approximately doubled the plant capacity of the Allegheny County Steam Heating Company.

The Stanwix plant, with a capacity of 600,000 lb. of steam per hour, and a smaller plant in the basement of the William Penn Hotel, previously had supplied the demand for commercial steam-heating service. By 1927, however, the building program in downtown Pittsburgh indicated a demand beyond existing capacity, and a site was selected for a new plant.

Dismantling an obsolete power plant on the site started on Jan. 16, 1928, and actual excavation for the initial unit commenced March 21. The capacity of one boiler was urgently needed for the winter load, and within eight months the plant was erected and the first boiler placed in service. Two and one-half months later, on February 1, 1929, the second boiler was put on the line. The site has space for four additional boilers, which will provide an ultimate capacity of 1,800,000 lb. of steam per hour.



Pittsburgh's new Twelfth Street central Heating plant

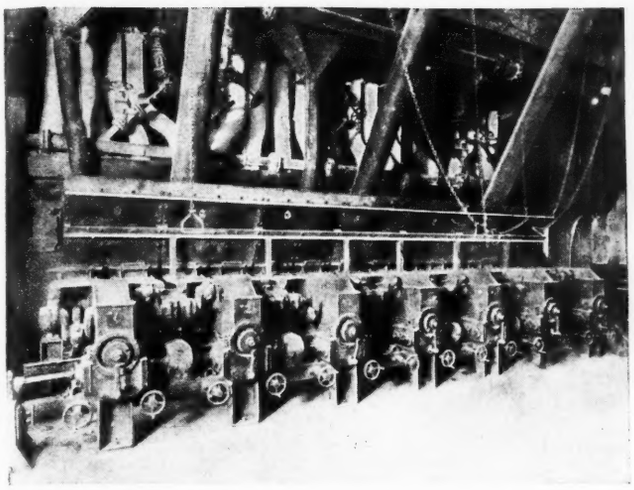


Interior of furnace, showing water walls

The initial unit consists of two twin Ladd boilers, each having 36,700 sq.ft. of heating surface. At normal rating these boilers generate 600,000 lb. of steam per hour, at 250-lb. pressure. Water walls protect the side and front walls of the furnace. They are fired from each end by underfeed stokers. The two stokers each have 14 retorts, 29 tuyères long, and at full capacity feed slightly over sixteen tons of coal per hour.

Ideal combustion at full load requires about 120,000 cu.ft. of air per minute. This is supplied by four 50,000-c.f.m. forced draft fans driven by 66-hp. steam turbines. Four induced-draft fans, each of 125,000-cu.ft. per minute capacity and driven by a 116-hp. turbine, deliver the flue gas to a 160-ft. stack. The stack is fifteen feet in diameter, is concrete-lined and contains approximately 35 tons of steel. It is self-supporting, and was erected and lined in about fifteen days.

Coal is dumped from the street level into two receiving hoppers, and is discharged into a crusher capable of reducing 110 tons per hour of run-of-mine coal to $1\frac{1}{4}$-in. size. It is then raised 120 ft. in a bucket elevator and distributed by two 24-in. belt conveyors 82 ft. long to four storage bins. The bins hold 135 tons each, and feed coal directly into the stoker



Boiler exterior and stoker at operating level. Note the hopper and spouts for returning to the stoker the soot collecting in the last pass.

hoppers. Air-operated cylinders are arranged to move the spouts that feed the coal to the stoker hoppers continuously back and forth, in order that the fine and coarse coal will be uniformly distributed across the stoker hopper. The soot thrown down in the last pass of the boiler is collected in hoppers that deliver the soot back to the stoker, as can be seen in the picture of the boiler exterior. The diagram of the building shows the locations of various pieces of apparatus.

Feed water is stored in the basement in tanks formed by subwalls and the building foundations. The tanks provide 900,000 gal. of storage. Make-up water is drawn from the Allegheny River and treated in a water-softening plant before storing. The water-softening plant has a capacity of 22,500 gal. per hour, which allows a constant addition of 30 per cent to the returned condensate.

Raw feed water is pumped approximately 500 ft. through a 20-in. steel pipe. This line was installed in a brick arch tunnel originally used for cooling water in the old power station formerly located on this site. The tunnel proved unsatisfactory, and a 36-in. pipe joined with inside flanges was installed inside it. For the new 20-in. line a shaft was sunk near the river end and lengths of pipe were lowered, butt-welded, and pulled through the 36-in. line. The end of the first length was coned to ride over the flanges of the 36-in. pipe, and little difficulty was encountered.

The greater part of the plant auxiliaries are driven by three-phase, 440-volt motors, and all except fractional horsepower units are equipped with safety switches and magnetic starters. The plant does not generate electricity for its auxiliaries, but is supplied by the Duquesne Light Company through either of two circuits from different substations. There is a storage battery for electrical control and emergency lighting.

One of the major construction problems was that of arranging the material-delivery schedule. With but eight months for construction, a limited storage space for incoming material, and with many shipments a project of this size requires, it was essential that material arrive in the proper sequence.

Three thousand feet of new transmission main was installed during 1928 to tie this plant into the distribution system. These mains and condensate return lines are laid under the street in concrete tunnels. The tunnels are of rectangular cross-section, and of sufficient size to permit repair and maintenance underground.

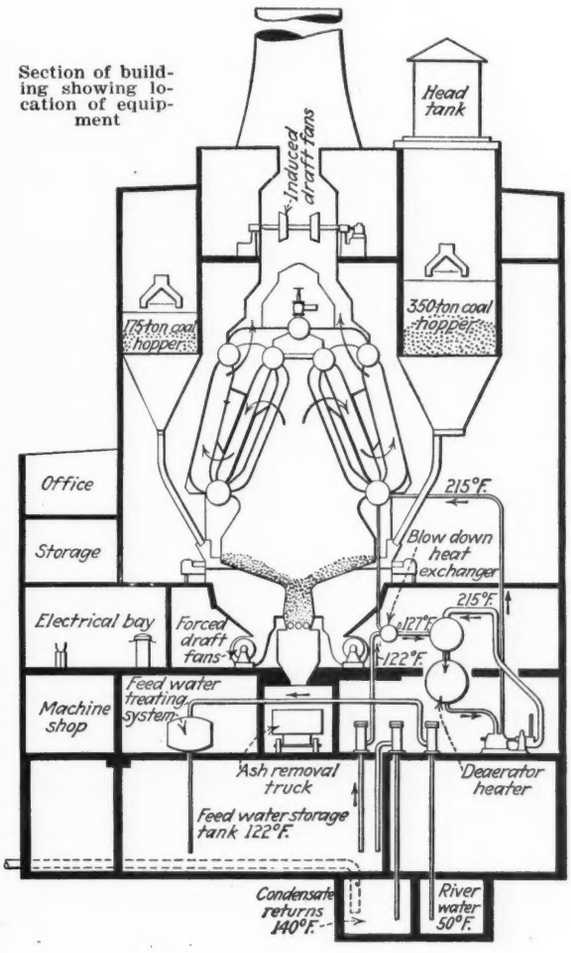
Expansion of the steam mains is taken care of by expansion joints and the piping is supported on welded structural steel.

The steam cycle begins with evaporation in the boiler. Steam is transmitted, at boiler pressure, through the high-pressure transmission mains into the low-pressure distribution system. Pressure-reducing valves are used to decrease the pressure between the transmission and distribution system.

The pressure on the distribution system is that best suited to commercial steam-heating equipment, and the customer's apparatus is connected directly to the low-pressure mains. The consumption is measured by the condensate returned from the customer's heating system. This condensate returns through pipe lines to the heating plant and is re-evaporated.

Commercial steam-heating service is now available to most of the dense business district of Pittsburgh. The new main connecting the Twelfth Street plant with the existing system passes through a rapidly developing business district and makes the heating service available to an area that heretofore was outside of the region that could be served from the previous distribution system.

Section of building showing location of equipment



[When the Stanwix plant was placed in operation, in April, 1924, the boilers installed had a heating surface of 32,750 sq.ft., and at that time were the largest boilers in operation. That large boilers are satisfactory for central heating plants is evidenced by the increased size of those installed at Twelfth Street. Although only six years have passed since the Stanwix boilers were installed they are now less than half the size of the largest in operation, which have produced 1,250,000 lb. of steam per hour.—Editor.]

Another Chapter in

ST. LAWRENCE RIVER

Power Development

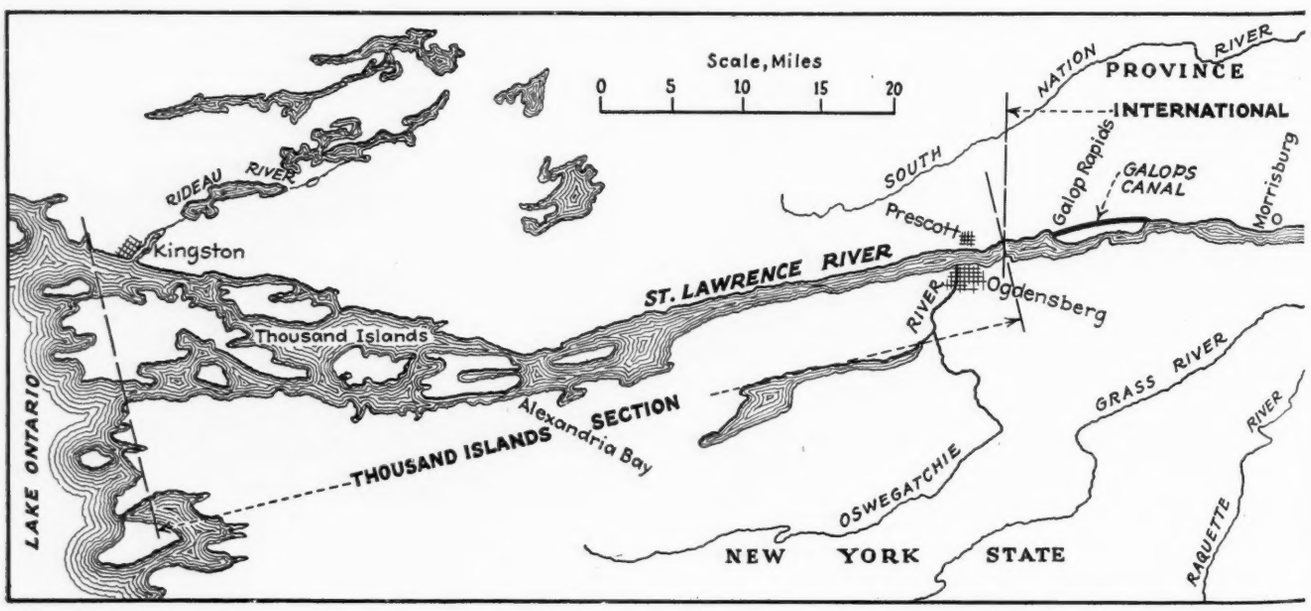
If New York State's Governor and Legislature agree upon a water-power policy, there remain national and international questions to be settled regarding the St. Lawrence River before power can be developed on its international section.

FROM Montreal to Lake Ontario, the St. Lawrence River is 182 miles long and falls about 200 ft. In this section over 5,000,000 hp. can be developed; 2,200,000 in the international section; 1,970,700 hp. in the Soulanges section; and 923,406 in the Lachine section. Of this power about 4,000,000 hp. belongs to Canada and 1,000,000 to the United States. This part of the river is also an important link in a proposed deep waterway from the sea to the head of Lake Superior.

The present interest in the St. Lawrence River power and navigation project is not new. The first important move toward studying the development was made in 1895. Since then the International Waterways Commission, the International Joint Commission, the Joint Board of Engineers, and other boards and commissions have sanctioned its engineering and economic features.

Along with the investigations made by national and international bodies, negotiations have been carried on between Canada and the United States looking toward a treaty between the two governments that would serve as a basis of developing the river for navigation and power. Although the economic and engineering feasibility of the project has received the sanction of virtually all the boards and commissions appointed by the two governments, no agreement has been reached between them as to the responsibility of each in the development.

Because the United States' share of the power that can be developed on the international section will come to New York, that state has a definite interest in the project. The State Legislature, about twenty years ago, granted a charter to private interests to develop the power. A few years later the charter was repealed. Other efforts have been made to obtain New York State's interest in this power, but they have not gotten beyond the stage of negotiation. The proposal that the state, under a power authority, develop the power of the international section of the river, made and fought for by Governor Smith during his eight years in office, has overshadowed all other plans for the project. State Legislature opposition to the plan resulted in a political



Map of St. Lawrence River, based on one accompanying the report of the Joint Board

deadlock between it and Governor Smith. When Governor Roosevelt came into office he again took up the fight for state development, and the political impassé between the executive and legislative branches of the government continued until a few days ago. Political obstruction seems to have been overcome by the acceptance by Governor Roosevelt of a bill now before the Legislature to empower the Governor to appoint a commission to investigate and report upon plans for power production on the St. Lawrence River. Even if the state does agree on a water policy there are many other obstacles that must be removed before work can actually start.

Before power can be developed on the international section of the river a treaty must be negotiated between Canada and the United States. If this treaty involved power only in the international section of the river, the problem might be simple, but it also includes a deep waterway from Duluth, at the western end of Lake Superior, to the sea. The question of division of costs between the two countries presents many difficulties that will probably require a long time to settle. Even when an agreement is reached it must be approved by the two governments. In both countries there are conflicting interests that, if they cannot kill the project, can cause long delays.

Although the United States has shown an interest in working out an agreement, Canada has not reciprocated. There are many indications which would lead to the belief that it will be several years before Canada will wish to seriously consider a treaty for the development of the St. Lawrence. At present that country is heavily committed to a short route from the west through Hudson Bay. A railroad to Port Churchill will be completed this year, and 1931 will see shipment made to the Atlantic by way of the northern route. Until this undertaking is completed and has proved its value to the Canadian West our neighbor to the north may be expected to hold off on the St. Lawrence project.

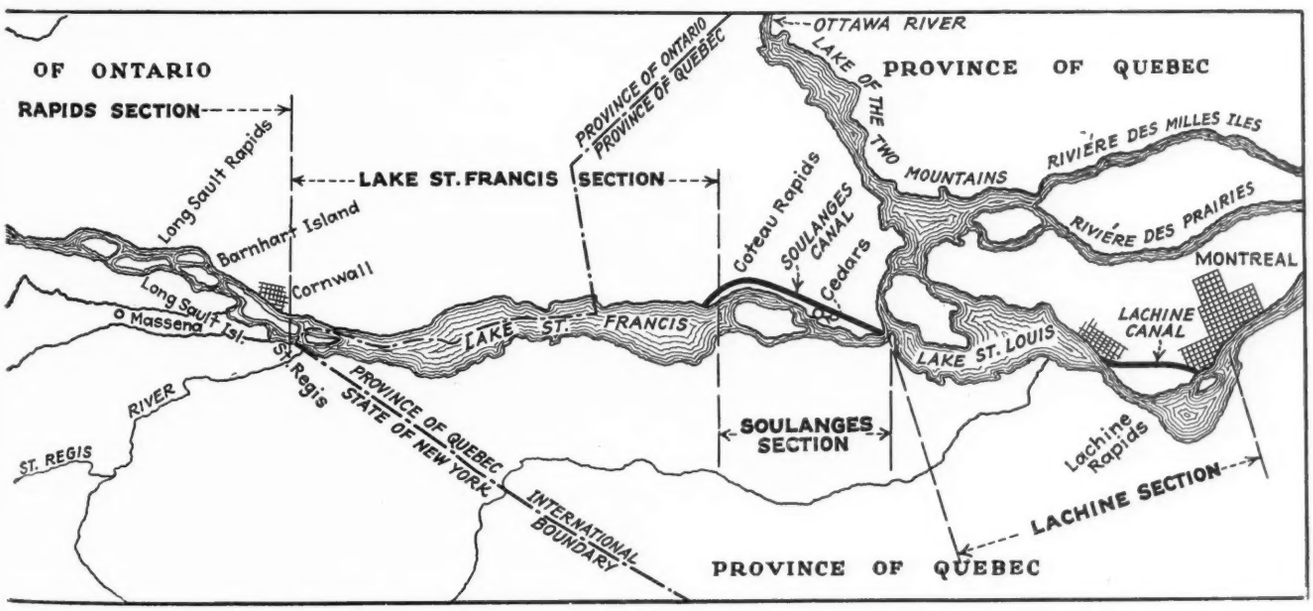
Eastern Canada even though favoring the development of the power when needed is not unanimously in favor of the deep waterway. Canada will not require the power in the international section of the river for many years to come. On the Canadian section there are 3,000,000 hp. that can be developed without a treaty with the United States. In addition, there are millions of horsepower of undeveloped water power on other rivers that can easily be brought into the region where power from the international section would be used. The Soulanges section of the river is now being developed for power by the Beauharnois Power Corporation, and although a power project is being made to fit into the International Waterways Commission plans for a deep waterway to the Great Lakes.

Even though an agreement might be negotiated between Canada and the United States for the development of the power on the international section of the river without involving the waterways project, it does not insure immediate development. The Province of Ontario has the right to the Canadian half. Power development in that province is practically a government monopoly, it being generated and transmitted by the Hydro-Electric Power Commission. As long as the province can obtain the power at low rates from other sources, it is unlikely to assume half the cost of a quarter-billion-dollar undertaking. Looked at from that angle, Ontario's interest in the international project need be only a minor one for several years.

The Canadian Board of Engineers reported for a two-stage development on the international section of the river when the United States board favored a single over-all development. Up to the present time an agreement has not been reached on this important detail, which must be settled before the development can be made.

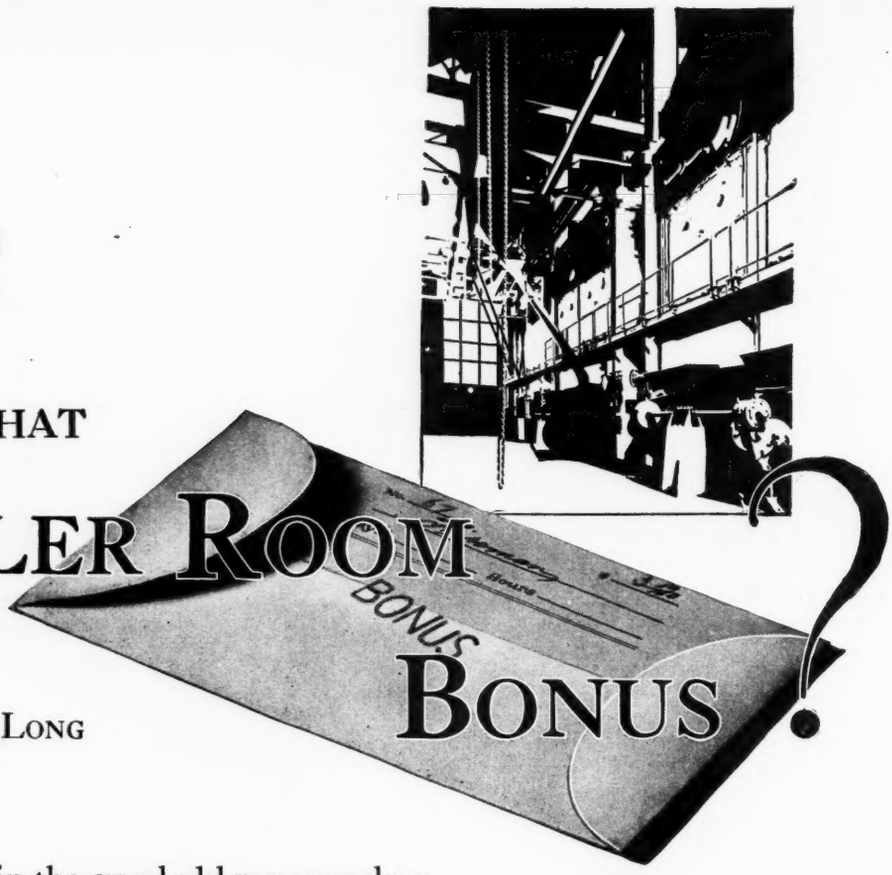
There are other difficulties—many of them in the United States—that must be surmounted before New York State can hope to develop power on the St. Lawrence. Those outlined in the foregoing, however, clearly indicate that the agreement between the executive and legislative bodies of the state government still leaves many obstacles to be removed before actual development can be started.

The most encouraging feature of the agreement between the Governor and the State Legislature would seem to be a willingness to try and settle their water-power policy differences at the same time that the international and other questions are being negotiated. If they do this it will be a desirable and worthy accomplishment.



of Engineers. The five proposed developments are indicated by the section divisions

WHAT HAS HAPPENED TO THAT BOILER ROOM BONUS?



By R. K. Long

Back in the good old pre-war days there was a lot of talk (and some action) on the boiler room bonus. Where has it flown? Why the silence? Are we overlooking something fundamentally sound?

MUCH was written about the boiler room bonus during the years immediately preceding the World War. When the war came the rationing of coal and other factors combined to shelve the bonus. And, apparently, it has stayed on the shelf, because practically nothing is said about it nowadays, and many plants that once used it have abandoned it.

Lost in the Shuffle

Why? Has it been "lost in the shuffle" and forgotten? Has it been tried and found wanting? Fuel is still expensive. The human element is as important as ever, determining what the over-all boiler-room efficiency will be. Why, then, has not the boiler room bonus "come into its own"; and why have not the firms that used it before the war brought it back again?

In the machine shop, the worker is paid according to what he does—piece work. The better his performance, the more he makes. It is fundamentally sound to pay a man what he is worth, and when he is worth more, to pay him more. This is the basic principle of the boiler room bonus, which is economically and psychologically justified.

Before the war, many felt that the bonus was more generally applicable to the big plant and that it was most justified there. As a matter of fact, the bonus is more easily developed for use in small boiler rooms, in spite of the fact that the large plant is more likely to have the personnel, the records, the equipment, the organization and stamina to develop and maintain a bonus system.

Granted that the boiler room bonus is fundamentally sound, and desirable, then why has it not come into wider use, why has its application lagged and in many instances failed? As the writer sees it, there are two major reasons, both of which lead back to the management.

Too Much Simplicity

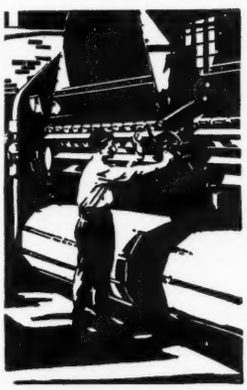
One of the chief reasons why so many forms of boiler room bonus ("profit sharing," if you prefer) fail is that in the search for a simple system, some of the fundamental factors involved are overlooked. Hence the bonus is not workable under all conditions or else becomes inequitable, with the result that it does not accomplish what was expected of it and ultimately dies a natural

death due to the failure of management or the boiler room crew. The second major reason why the boiler room bonus has so often failed to accomplish what was expected of it is that the inducement for the men to save was not sufficiently attractive. To say that the management was not sincere might be too severe. Perhaps it is that management was "holding back."

Bonus Must Be Fair

To work, a boiler room bonus must be equitable. It must be complete enough to safeguard the man who pays for the fuel, while the reward must be sufficiently big to induce the man who handles the fuel to try to save it. A lopsided bonus which means more work for the men with an insignificant profit, while the saving goes to the management, is not fair—and it does not take the men very long to find out that their extra effort is out of all proportion to the profits in the savings. Therefore, the bonus must, above all, be fair.

Secondly, it should be such that the men are able to figure out themselves what they save, so that they may know what they have coming as their share of the savings. Secrecy and mystery breed suspicion. Frankness is the basis of confidence; and confidence is the only lasting basis of co-operation.



Some would base the bonus on CO_2. So much has been said about this that many people seem to think that power plants exist to make CO_2, instead of to produce power or steam. After all, who really cares about how much CO_2 is developed, if more power at lower cost can be produced with less of it? A clever combustion engineer is able to manufacture CO_2 while doing little work, while the man on the boiler next to him may be doing most of the work but developing less CO_2.

Pounds of fuel against pounds of water evaporated or kilowatt-hours generated seems to be the most practical and fundamentally sound yardstick by which to measure the bonus. It embraces only the boiler room crew in the former case, while it may include also the engine room crew in the second case. Such a basis of profit sharing minimizes the variables, such as the inherent characteristics of the load, changing with each shift; the numerous conditions over which the men have no control, such as banked fires, forced rates of evaporation during the peak load, units out of service due to repairs, etc. All of these militate against the premise of the bonus based upon CO_2 and, to a smaller extent, against the bonus based upon over-all input of fuel with output in kilowatt hours or pounds of steam.

Coal analyses are made in comparatively few plants, and no comparison of input and output means very much unless the analysis of the coal is known. To what extent is this fact holding back the bonus?

How, then, should a bonus be developed and what proportion of the savings should be apportioned to the boiler room crew, on what basis of remuneration and how divided? Should the total savings per week or per month be divided equally among the boiler room crew or in certain ratios or how? Surely, the application of steam-flow meters, coal-weighing equipment and boiler room instruments has made great strides since 1914. In that case, many of the factors involved in the boiler room bonus must now be known that before the war were not known.

Fundamentally Sound

Fundamentally the bonus is sound, for it is the counterpart of piece work in the factory, where remuneration or reward rises and falls with the output or performance of the worker. The boiler room is merely a factory where the manufacturing process is to convert the latent energy of coal into steam or electricity. So, why not piece work in the boiler room as well when it is so conducive to efficient workmanship and savings to the management.

The readers of *Power* would like to know of the different forms of boiler room bonus now in vogue, how the rates of reward were derived, what equipment is employed in making them possible and to what extent the use of a bonus has profited the management and the men. Why have plants that used the bonus before the war not put it into force again? Where they failed, was it because the bonus was not great enough to interest the men or because the compensation more than counterbalanced the saving to management?

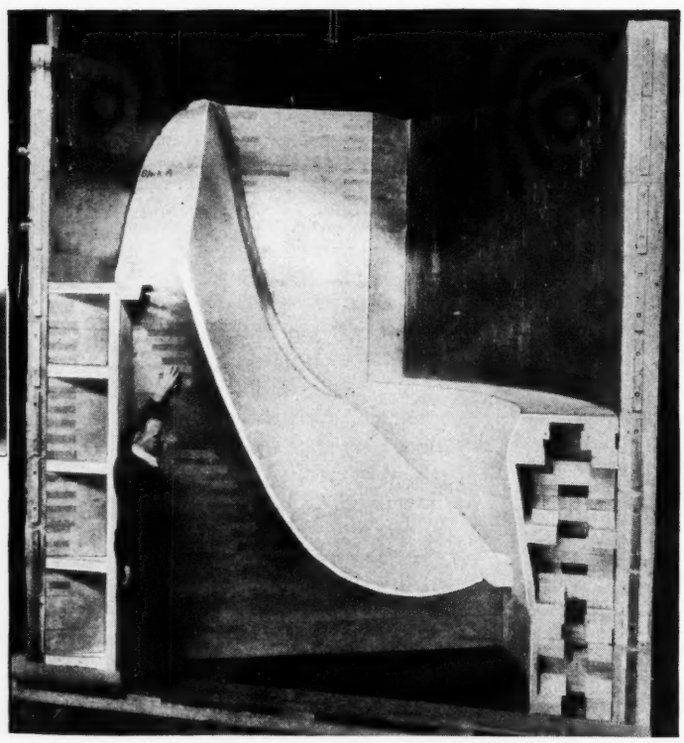
What Is the Answer?

In other words, what is the status of the boiler room bonus and what is to be expected of it within the next few years? Was it a fad, an academic theory too Utopian to find a permanent place in boiler-room operation? Or did it turn out to be something the men thought was being put over by management to get something for nothing? Or can it be that the boiler room is now so efficient that the management feels nothing can be gained in trying to save more fuel and in encouraging savings by sharing them with the men?

If the bonus deserved to die a natural death, let it rest. If it was a good thing, let's revive it—and apply to it the vast amount of experience which has been gathered during the last fifteen years.

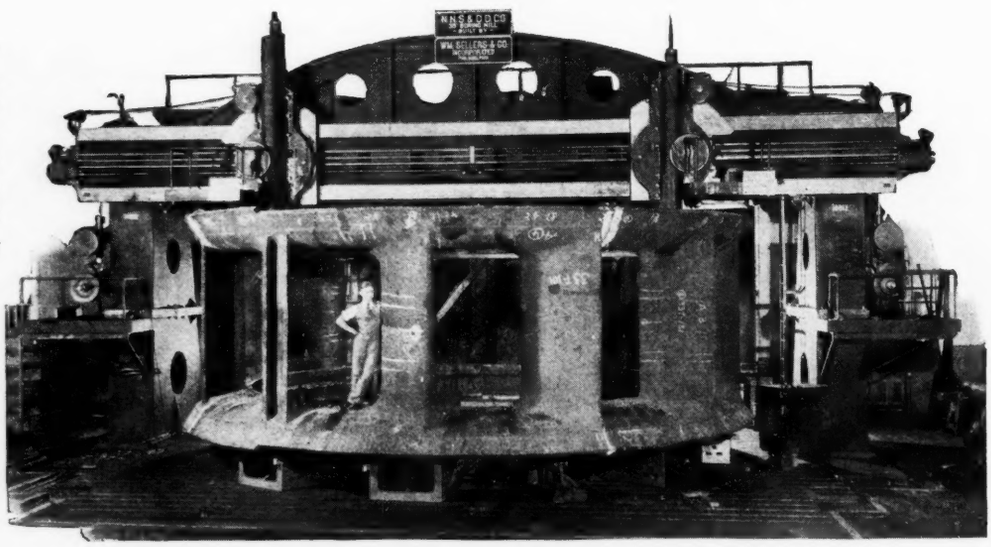
SOME BIG FELLOWS in HYDRO MACHINERY

Above—One of the two 54-in. mechanically operated pressure regulators installed on two 29,000-hp. units in the International Power & Paper Company's Deer Lake plant, Newfoundland



Above—Runner-vane core box for a 57,000-hp. 81-ft. head wheel for the New York Power & Light Corporation's Spier Falls plant

Right—Speed ring for one of four 84,000-hp. 116.5-ft. head wheels being built for Dnieprostroy development U.S.S.R. The speed ring is 28 ft. in diameter and weighs 160,000 pounds



Photos by courtesy of the Newport News Shipbuilding & Dry Dock Company.

CORROSION FATIGUE

AN EXPLANATION OF BOILER-PLATE FAILURE

By CAPT. H. C. DINGER, U.S.N.
Engineering Experiment Station
Annapolis, Md.

Various theories have been advanced for the initial cause of boiler plate failures, particularly those manifested as cracks after a considerable period of service where the stress has never exceeded or approached the elastic limit. These theories usually try to visualize some special condition, as (1) a more or less hidden cause that has produced excessive strain, (2) failure due to surface corrosion, or (3) caustic embrittlement.

I THINK it will be admitted that the theory of caustic embrittlement does not give a plausible explanation for many boiler plate failures, because they are found quite frequently where there has been no caustic condition of the feed water or any unfavorable carbonate-to-sulphate ratio. Furthermore, there is no actual embrittlement of the metal. The term embrittlement is misleading. The metal fails due to progressive cracking, but the structure of the metal adjacent to the crack does not become any more brittle than it ever was.

The condition of the water or other corroding media in contact with the metal while under stress, however, does have a very material effect upon the acceleration of the cracking. To this extent the idea of maintaining a non-destructive condition of boiler water has a sound basis. However, this is not embrittlement, but probably an action on the part of certain ingredients in the water that destroys the protective film which otherwise would form on the bare surfaces of the pit or crack that is the initial starting point of the failure. To what extent various waters accelerate corrosion fatigue, pitting and cracking under boiler conditions has not been adequately investigated.

A proper study of the fatigue action of metals will serve to throw into the discard the ideas that metal becomes either crystallized or embrittled due to application of loads at temperatures such as are encountered by the water sides of boilers. These ideas persist to an alarming degree and account for much irrational discussion.

Any condition which produces unrelieved or locked-up stress in the boiler plate is a potential cause for eventual failure. These initial internal stresses are often not well understood, but suitable relief annealing will often avoid failures from this cause. Some mysterious failures have their origin in locked-up or unrelieved stresses. Usually, however, a thorough examination of a fatigue crack will disclose that the part was subjected to repeated excess stress of sufficient frequency and magnitude to account for the failure during its period of service.

Experience and an examination of many failures make it quite apparent that those due to fatigue cracks in boilers, conform to the following:

(*a*) They develop invariably at the points of greatest fiber stress.

(*b*) They are found almost exclusively below the water line.

(*c*) They are often found in locations where metal has been mistreated in fabrication or construction.

(*d*) They will be found where the metal has been subjected to concentrated cyclic stress from any cause, such as a bending or weaving action due to expansion, contraction or other movement of parts which may set up special stress in certain relatively weak members.

(*e*) Fatigue cracks very often appear to develop where the maximum fiber stress has been well below the elastic limit. Hence, mystery surrounds them.

(*f*) They never occur in parts that are not stressed beyond the safe and conservative fatigue limit.

It has been noted that in nearly all of the discussions of failures to date no reference has been made to the phenomenon of corrosion fatigue. Yet, when failures are considered in connection with corrosion-fatigue information, a clear, logical and definite explanation of the basic causes of the failure can nearly always be presented.

It has been found by experiments in corrosion fatigue carried on at the engineering experiment station, Annapolis, Md., under the direction of Dr. D. J. McAdam Jr., during the past six years that failure will be initiated under conditions of cyclic stress when the metal is exposed to a corroding medium at stress much below the elastic limit and well below the ordinary endurance limit.

For ordinary Class B boiler plate, the endurance limit (in air) is about 28,000 lb. per square inch. The corrosion fatigue limit in fresh water is about 18,000, and in salt water about 8,000. These corrosion-fatigue limits were obtained by rotating bend tests at 1,450 r.p.m. for a period of 10 to 40 days in contact with water.

Corrosion-fatigue limits thus obtained by tests for a short time and at relatively high speed are of value in comparing the behavior of various metals under simultaneous corrosion and cyclic stress. They cannot, however, be directly applied to design formula for boilers. In boilers the cycles are usually of low frequency applied over a long period of time. Investigation at the naval

experiment station, however, has included cycle frequencies varying from 10,000 per minute to 1 per hour. This has resulted in data represented by three-dimensional diagrams illustrating the effect of stress, time, and number of cycles in causing damage to metals under corrosion. Taken in connection with information obtained from examination of boilers, the diagrams lead to the conclusion that for the ordinary class B boiler plate the fiber stress in no pressure part subject to the action of the boiler water should exceed 10,000 lb. per square inch, and that 9,000 would be a better value to aim at.

Knowing this, it is not so difficult to account for the failure, since a fiber stress of 14,000 lb. per square inch will produce a failure within a reasonable time provided the part is subjected to cyclic stress. In other words, for this material, Class B boiler plate, a factor of safety of 6, if adhered to, will give a safe boiler; a factor of 5 a somewhat doubtful one; and a factor of 4 a dangerous and unsafe one.

There are numerous boilers in service where certain parts, due to the design, construction and operating condition, are subject to repeated loads which produce a localized fiber stress considerably in excess of 10,000 lb. per square inch. Such boilers are likely to fail some time without regard to condition of feed water. If feed water is unfavorable, such as sea water or water high in certain salts, the fatigue failure will be accelerated. Hence while proper conditioning of feed water does have a considerable effect in retarding failure; bad water, of itself, is not the fundamental cause of fatigue cracks. The burden of proof is not entirely in the province of the user. The greater part of it rests upon the designer and manufacturer.

Defective Workmanship Responsible for Most Failures

Defective workmanship is responsible for most of the cases where excessive stress concentration is produced. The following may be mentioned:

(*a*) Using punched instead of drilled rivet holes.

(*b*) Leaving burrs on rivet holes, which prevent plates coming metal to metal.

(*c*) Improper forming of plates, so that the load of bringing plates together and holding them there comes upon the rivets, overloading them, is one of the principal causes of rivet heads snapping off.

(*d*) Defective riveting and irregular spacing, which causes excessive stress on those that actually hold and allows some local bending action on the ligaments, and which may cause high stress of an intermittent nature on the rivets.

(*e*) Excessive calking, thereby weakening plate at a point of stress concentration.

(*f*) Use of lap joint where a well-supported butt strap should be used to stiffen and prevent a bending action in the joint.

(*g*) Using rivets that have no fillet or are undercut under the head: A second reason why some rivet heads snap off when hit by a hammer.

(*h*) Joining pressure parts together in such a way that bending moments are caused in weak spots due to expansion and contraction or other movement.

While the formation of fatigue cracks in pressure vessels may be accelerated somewhat by the condition of the feed water, no feed-water conditioning can overcome the initial defect of an overstressed part; therefore, the real cure for fatigue failure in these parts is to locate where and why these overstressed parts exist; to see that no part or portion of them is stressed beyond what sound engineering and a consideration of corrosion-fatigue data indicates to be a safe and conservative limit. The corrosion-fatigue limit for boiler plate in salt water would appear to be a safe limit to guide the boiler designer in establishing the maximum fiber stress that would be permissible on any part of a boiler below the water line. It is doubtful whether any feed water is worse than salt feed.

Corrosion Fatigue Occurs Even With Distilled Make-Up

We have had numerous instances where corrosion-fatigue cracks developed in tube sheets and heads of boiler drums, where the parts were designed on the basis of fiber stress of 10,000 to 11,000 lb. per square inch, but where, due to various minor discrepancies and inaccurate workmanship, localizing stress may have gone 10 or 30 per cent above this. These boilers failed despite the fact that they had been fed with distilled make-up and had never experienced any high concentration of caustic. Similar parts in the same boilers, but subject to slightly lower stress, are often found to be perfectly sound.

The presence of the fatigue cracks in certain special localities is clearly explained on the basis of high stress or stress concentration in connection with the phenomenon of corrosion fatigue, and no other plausible explanation has yet appeared.

It is possible by investigation and examination of the design and installation of a boiler to locate the points that may be stressed beyond safe practice and to take steps either to strengthen these parts (welding is often feasible) or to operate them under a lower pressure to reduce the fiber stress to safe limits.

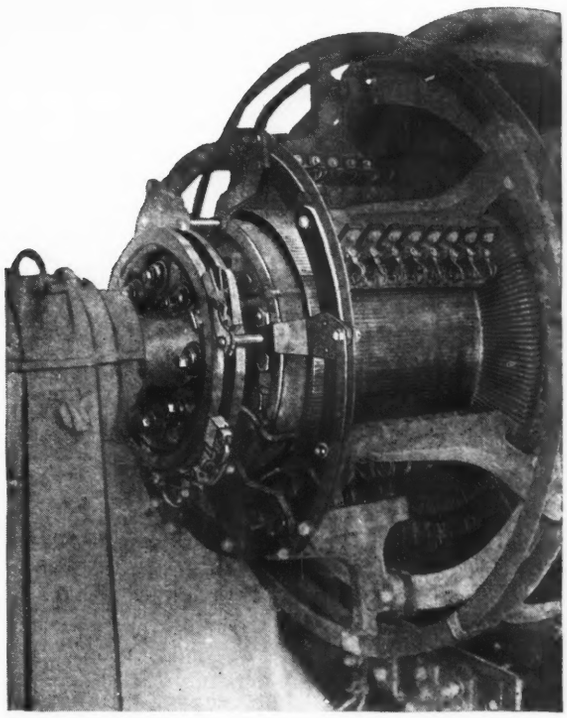
Tests are now under way at the experiment station to determine corrosion-fatigue behavior of various recommended materials contemplated for use in high-pressure boilers, with a view of determining which of the several materials may be considered most desirable, and also the safe fiber stress that may be used for each. It is hoped to have this, and some other information in connection with the matter, available in the course of a few months.

Books

BEGINNING with the Feb. 4 number POWER will inaugurate a new book section. Broader in scope and critically more authentic, this feature will henceforth appear regularly the first issue of every month. It is planned to include, whenever possible, reviews of outstanding economic studies and biographies of noted engineers, in addition to critical analyses of technical treatises as presented in the past. Suggestions as to the type of book you would like reviewed will be welcomed by the editor.

Operation of Three-Wire GENERATORS

By C. LYNN
Power Engineering Department
Westinghouse Electric & Manufacturing Company



Commutator and slip rings on a three-wire generator

Engineers who have operated two-wire generators may find three-wire machines confusing when they handle them for the first time. This article explains the difference between the two types of machines, shows how the neutral is produced, and how to operate three-wire generators in parallel

THREE-WIRE direct-current distribution, generally of 125 and 250 volts, is used extensively in industrial plants where electric power is generated, and in many other plants where alternating current is converted to direct current. The many advantages of direct-current over alternating-current motors in industrial applications, the saving in copper costs for distribution when using 250 volts instead of 125 (at the same time having the latter for lighting and for small devices) justifies the use of a three-wire system.

The armature winding of every commutating direct-current generator has an alternating voltage generated in it, and direct current is obtained through the use of a commutator and brushes. Alternating current can be obtained from a direct-current armature by connecting the winding to slip rings and through brushes to the load. The photograph shows the commutator and slip-rings of a three wire generator.

On a simple three-wire direct-current generator two collector rings are added to the generator, and these are electrically connected to the armature winding to give single-phase alternating current. The voltage of this current as read by voltmeter will be 70.7 per cent of the direct-current voltage of the generator. Its frequency, in cycles per second, is equal to the generator's speed in revolutions per minute times the number of main poles divided by 120.

There can never be more connections from the armature winding to each ring than there are points of equal potential on the armature. With a multiple winding, there can be as many connections per ring as there are pairs of main poles. With a two-circuit wave winding, there can be only one connection per collector ring, irrespective of the number of pairs of main poles. Since two collector rings provide single-phase alternating current, the connections to the two rings must be 180 electrical degrees apart. This is shown in Fig. 1 for a multiple-wound armature, and in Fig. 2 for a wave-wound two-circuit armature.

A balance coil consists of a single continuous winding on a laminated-iron core. When such a coil is connected to the collector rings of a three-wire generator, as in Fig. 3, its middle point provides a neutral connection for a three wire system. If two direct-current voltmeters are connected from M, the middle point of the balance coil, to the positive and negative brushes, respectively, voltages equal to one-half that across the commutator will be obtained.

Some manufacturers instead of supplying two collector rings with brushes and a stationary balance coil build the balance coil in the spider of the armature, so that it can rotate with the armature. In such cases only one collector ring is necessary, but this ring and the brushes must be of twice the capacity of either of the rings where two collector rings and an external balance coil are used. Other manufacturers put the balance coil winding in the slots with the armature winding. These slots must, of course, be deeper than if the winding were not there. The objections to these two types of constructions are that the balance coils are located in space that could be more advantageously used for generator output. Repairs are also more difficult and costly to make. A failure of the balance-coil winding necessitates taking the generator out of service for the time required to repair the winding.

Fig. 4 shows diagrammatically a three-wire generator carrying a balanced load and an unbalanced load simultaneously on the positive side of the system. The figures

on the arrows show the magnitude and direction of current flow under the assumed conditions of loading. Two currents exist in the balance coil simultaneously. One is a small alternating current (not indicated on the diagram), which acts as a magnetizing current for the balance coil and provides the neutral point. The other is a direct current (the unbalanced load current), which enters the balance coil at the middle point and divides, approximately half flowing in each direction through the coil to the armature. The actual division depends upon the rotating position of the tap to the collector rings in respect to the direct-current brushes. In Fig. 4 the current divides one-half in each side.

When a generator's load is unbalanced the voltage on the heavier loaded side drops slightly, and that of the other side increases, since the sum of the voltages on each side of the neutral must equal that between the outside wires. This decrease in voltage is due to the resistance drop of the unbalanced load current flowing in the armature, series and commutating field winding and in the balance coil itself.

If the connections from the collector rings to the armature coils are not correctly made, and more coils are included between taps on one side of the armature and the collector rings than on the other, the voltages on the two sides of the system will be out of balance and lights connected to the neutral wire will flicker. Ordinarily, with the load out of balance equal to 25 per cent of the rated current of the machine, the voltage difference between the neutral and the outside wires will not exceed 1½ per cent of that between the outside wires.

Twenty-five per cent of the rated current of the generator is generally considered the maximum unbalance permissible. If the unbalanced current is greater than this, commutation will begin to be impaired, due to unbalance in the commutating magnetic circuit. The armature conductors connected to the commutator bars passing under the brushes carrying the greater current will need a stronger commutating field than the conductors connected to commutator bars passing under the brushes carrying the lesser current. Neglecting leakage, all commutating poles will be the same strength under any unbalanced-load condition.

To have the field poles of equal strength, the commutating-pole field and compensating-field windings, when used, are divided and one half of the coils are connected to the positive side of the armature and the other half to the negative side. This is indicated in Figs. 5 and 6. Not only is it necessary to connect half of these coils on one side of the armature and half on the other side, but all south poles must be on one side and all north poles on the other side. If not, some of the commutating poles will not have a magnetic flux through them when the load is all on one side of the system. This can be

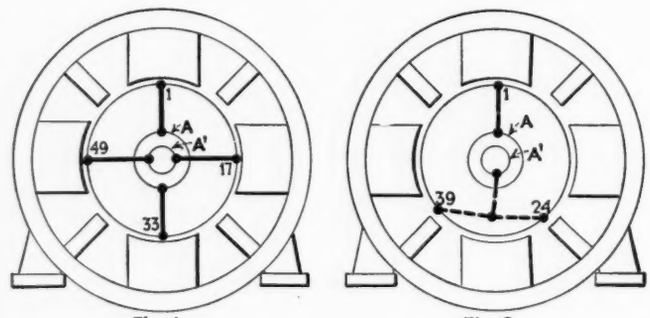


Fig. 1

Fig. 2

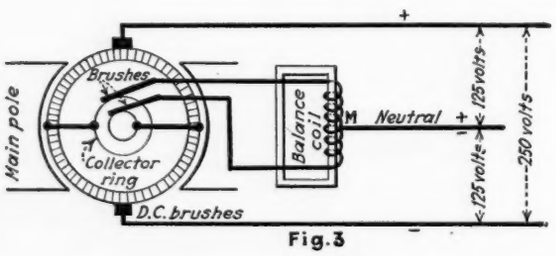


Fig. 3

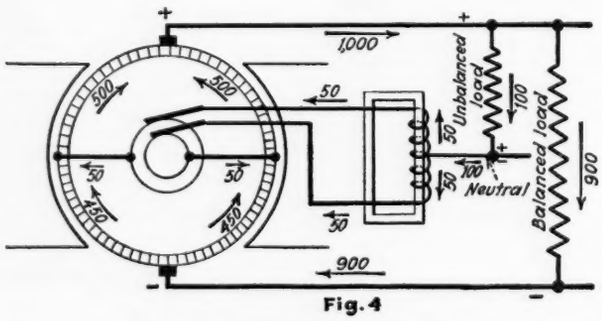


Fig. 4

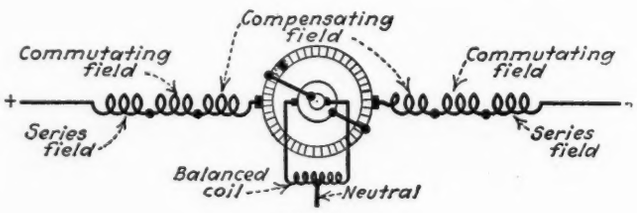


Fig. 5

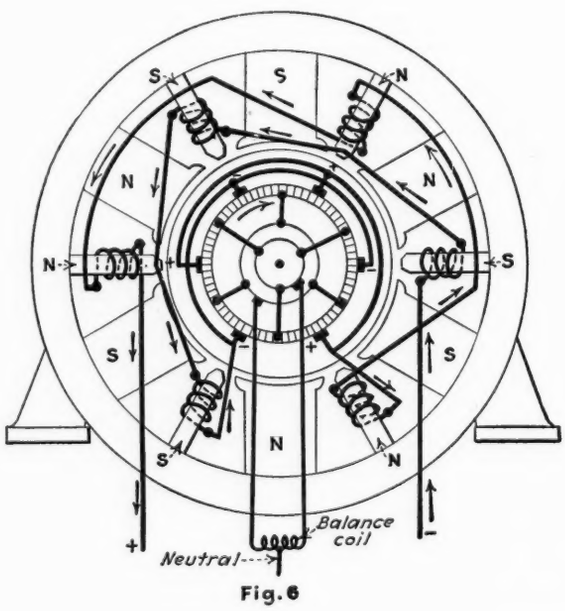


Fig. 6

Elementary diagrams of 3-wire generators and their connections

Fig. 1—Connections to the slip rings of a 3-wire 4-pole multiple-wound generator with 64 commutator bars, ring *A* is connected to bars 1 and 33, rings *A*¹ connect to bars 17 and 49. Fig. 2—Connections to the slip rings of a 3-wire 4-pole 2-circuit wave-wound generator with 61 commutator bars; Ring *A* connects to bar 1 and ring *A*¹ connects to the rear center of the armature coil that is connected to bars 24 and 39. Fig. 3—Diagram of a 2-pole 3-wire generator with a balance coil and 2 collector rings. Fig. 4—Diagram of a 3-wire generator supplying an unbalanced load; the arrows and figures indicate the direction and value of the direct current flowing in the circuit. Fig. 5—Diagram showing how the series-, commutating- and compensating-field windings are divided on a 3-wire generator. Fig. 6—Diagram of a 3-wire generator showing how the commutating-field winding is divided and connected to the commutator; the connections between the balance coil and the slip-rings and the commutator are also shown. All the *S* pole coils are connected to one side of the armature and the *N* pole coils to the other.

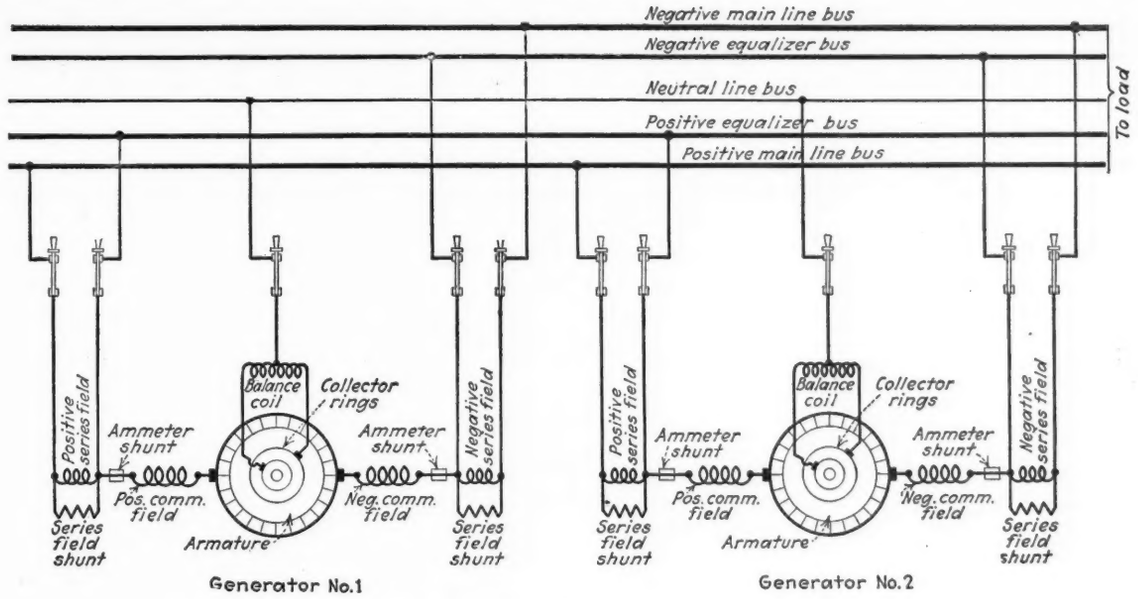


Fig. 7—Simplified diagram of two 3-wire generators connected in parallel

readily understood by reference to Fig. 6. The commutating-pole flux passing from any one pole into the armature can be considered as dividing, each half passing through the armature in opposite directions and returning to two adjacent commutating poles and the generators. The series-field winding, when one is used, must also be divided in a similar manner, so that proper compounding will be obtained irrespective of loading on the generator. No change is necessary in the shunt field or its connections for use on a three-wire generator.

Parallel operation of three-wire generators differs slightly from that of the two-wire type, although the principles involved are the same. Since there are two series fields, two equalizers must be used, as well as two equalizer switches. The neutrals are also paralleled, requiring the use of neutral switches. Two ammeter shunts per machine are required, connected inside the equalizer connection. If the shunts were located at the switchboard, the ammeters would indicate not only the load currents, but any equalizing currents flowing from one generator to another. The unbalance current is the difference between the negative-line ammeter reading and positive-line ammeter reading. Fig. 7 is a diagram of two three-wire generators operating in parallel. When paralleling three-wire generators, after the voltages are equal, close the neutral switch first, then the equalizer and line switches.

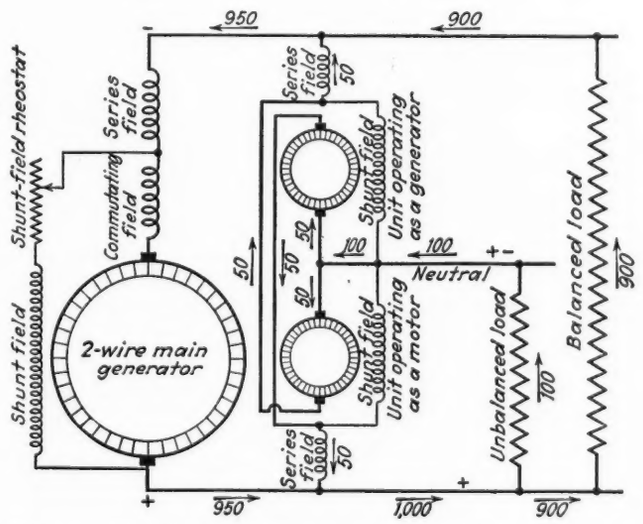


Fig. 8—Simplified diagram of a 3-wire system obtained from a 2-wire main generator and a balancer motor-generator set

Three-Wire Balancer Set

There is a method of securing three-wire service from a standard two-wire direct-current generator by using a balancer set, as indicated in Fig. 8. The balancer set consists of two duplicate, generally compound-wound, direct-current machines, coupled together and mounted on a common bedplate. The voltage rating of each is one-half that of the main generator, and the current rating should be one-half of the unbalanced current to be carried. The speed of the machine may be any value suitable to the size of the units.

When the systems load is balanced, each balancer unit operates as a motor, requiring only enough current to overcome the losses at no load. With an unbalanced load on the system, the unit on the high-load side operates as a generator, and the other unit as a motor. As indicated in Fig. 8, each unit has the same current in its armature, and this would be true were there no losses in the units. There are losses in each machine, however, and the voltage across the generator side will be less than that across the motor side. The current in the motor side will be greater than the current in the generator side, inversely in proportion to the voltage on each unit. By crossing the series- and shunt-field windings of each unit, as in the figure, less unbalance of voltage will occur. The generator's shunt and series fields will be strengthened, which will tend to raise its voltage. The motor's field will be weakened and it will tend to increase in speed, thus increasing the output voltage of the generator unit and more nearly equalizing the voltage on each side of the neutral. The disadvantages of using a balancer set are the higher first cost and greater operating losses and the maintenance required. The main advantage lies in its easy adaptation to existing two-wire units to obtain three-wire service. In this system the percentage unbalance of the load is limited only by the size of the balancer set.

TESTING TURBINE LUBRICATING OIL

Without a Chemist

By H. O. MICHAEL

FOR the engineer of a turbine plant who has no well-equipped laboratory and chemist to test his turbine lubricating oil, the "borax test" is a simple and reliable method. While it does not give a mathematical index, such as the acid number does, its continuous use at regular intervals will enable the operator to judge the condition of his oils with surprising accuracy. I have used this test for more than four years at weekly intervals while watching the condition of the oil in nine steam-turbine generating units totaling 165,000 kw., and the indications have, with rare exceptions, been confirmed by tests made by a prominent firm of consulting and analytical chemists.

The borax test simply indicates how well an oil resists emulsification, an emulsion being an intimate mixture of an oily substance with water. Oil in excellent condition will precipitate or throw down the borax as quickly as it would clean sand; while a poor oil will form a mixture, or emulsion, with the borax and water, and the borax will precipitate slowly, and some of it may be held in suspension in the oil indefinitely. The manner in which it precipitates and the appearance of the sample during a settling period of, say, a week, will allow the operator to accurately judge the condition of his oils.

This test will immediately indicate the presence of animal or vegetable oils blended with a mineral oil, by producing a thick stringy emulsion. Consequently, it cannot be used to any advantage to indicate the condition of any but pure mineral oils. Turbine oils being all-mineral, this feature may be ignored.

The equipment for making the borax test consists of a number of four-ounce vials, or bottles; a box of borax; and a teaspoon. A small rack should be made to hold as many vials as there are batches of oil to be observed.

When making a test take a representative sample of an oil in active circulation from the reservoir of a unit; the vial should be marked for that unit by a metal tag wired to its neck. Next pour back all of the oil but 1½ in., and add a heaping teaspoonful of borax, followed by enough water to bring the oil level to within 1½ in. of the vial top, as shown in Fig. 1. The quantity of borax need not be accurately weighed or measured, since the excess will merely settle to the bottom of the vial. Hold the thumb over the opening of the bottle and shake it violently; then observe its contents.

If the oil is new or in good condition, the mixture will not be very intimate and can hardly be called an emulsion. It will be almost entirely full of globules of oil, with water between, and as soon as the shaking is stopped borax will begin to settle out, followed by a layer of water, which will grow in height as the volume of oil and water mixture shrinks to the size of the original sample of oil. A few oil globules, match-head in size, with or without borax attached, may hang at the bottom of the oil layer, as indicated in Fig. 1. With some oils, a considerable amount may hang in this manner.

Figs. 1 to 7—Behavior of a lubricating oil after it has been mixed with water and borax

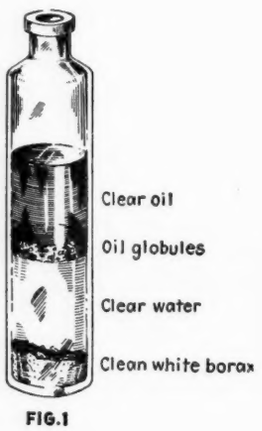


FIG.1

FIG.2

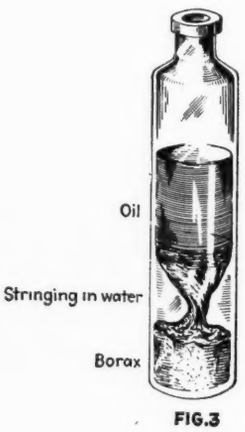


FIG.3

Should the oil be old in service or worn out, several reactions may take place. After shaking, the oil, borax and water may have mixed intimately and have formed a smooth, creamy emulsion. For several minutes perhaps, it will remain in this condition, then small globules will be seen to form; finally, a "neck" of the mixture will be seen growing at the bottom, surrounded by water, somewhat as in Fig. 2. This neck will get narrower and longer and may finally pull apart, leaving borax at the bottom supporting a water layer, and on top of the water the rapidly shrinking oil-mixture layer. Globules heavy with borax may be observed falling through the water, and similar globules which have freed themselves of the borax may be seen rising.

In some cases the "neck" will not pull apart but will stretch out into one or several strings, which may break quickly or may remain intact, as in Fig. 3. Occasionally, a string may break apart, part of it falling to the borax, and part rising to a position under the oil-mixture layer, where it will form a lump, which may hold its form for several days.

In addition, oil in poor condition may also stick to the glass sides of the vial; or, besides stringing, the emulsion may divide into several layers or strata, of different shades of yellow and brown.

Fig. 4 shows an oil in bad condition after settling one week, and Fig. 5 shows the same oil after shaking and after the neck shown in Fig. 2 had broken.

A record of how the oils behave should be kept, entries being made after the borax is added and when it is again observed following a period of one week.

The treated samples should be placed in the rack and put away to settle at room temperature for a week. They should then be examined before shaking. If the sample is new or in excellent condition, the oil strata will contain clear transparent oil, the water strata will be clear and transparent, and the borax will be clean and white.

FIG.4

FIG.5

FIG.6

FIG.7

If the sample has had considerable service, and the oil is in good condition, the oil strata will be composed of oil that resembles the original sample in color but is not perfectly clear. The water below it will be slightly yellowish in color, and the borax at the bottom will probably be tinged with yellow.

Should the sample be from oil which is in but fair or poor condition, the oil layer will be divided. A strata of nearly clear oil, varying from $\frac{1}{8}$ to perhaps 1 in. in thickness, of the same color as the original sample, will be at the top, and below will be a strata of emulsified oil, usually light brown or mustard color. The water will probably be a dirty yellow, with, perhaps, a greenish cast; and the borax will be mixed with and partly covered by brownish oil globules. The thickness of the clear oil strata at the top will serve as a further index of the conditions in this range; the thicker the strata, the better the condition of the oil. The state is shown in Fig. 7.

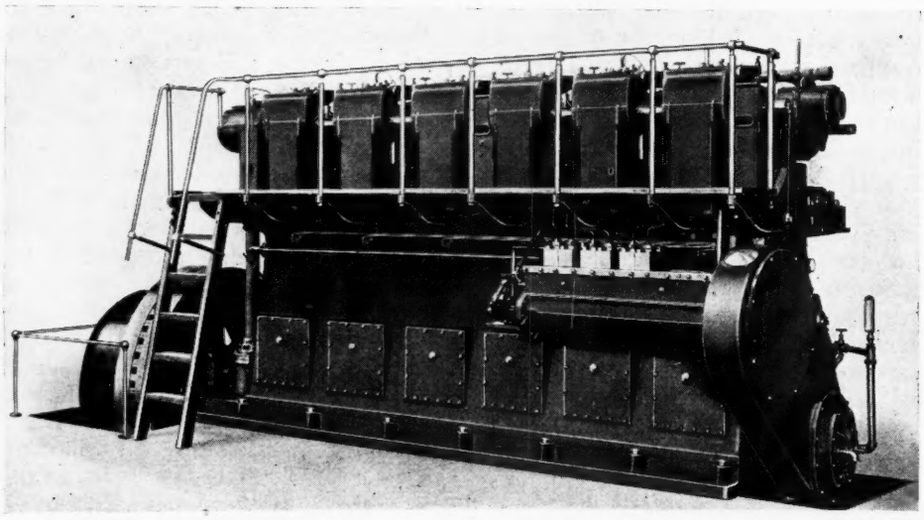
Finally, an oil in bad condition will show some or all of several conditions after a week's settling. There may be no clear oil whatever on top of the oil layer, or the oil layer itself may be divided into two or more colored strata of oil emulsions. These strata may vary in color from mustard to dark coffee brown, and the division between them will probably be irregular. Below the oil layer and forming part of the water layer there may be a white ring of emulsion. Brown or black specks may also form a ring at this point. Occasionally the ring may be of a smoky, thin emulsion, if the oil is in better condition. Sometimes this ring will not be present at all. The water below will be discolored, usually brown (sometimes with a green cast) and it may be dark enough to be opague. The borax will be entirely dirty and brown in color and will be mixed with brown globules, as in Fig. 6.

After the samples have been observed in their settled state, they should be shaken, one by one, and again observed. All of the conditions noted immediately after the borax and water were added and the vial was shaken for the first time will again appear, and in an emphasized form. This should also be recorded.

In caring for several batches of oil, those that are indicated to be poor should be removed from service and run through a separator or filter and later placed in service. Those that appear to be in bad condition should be given such drastic treatment as water washing, followed by settling and separation, depending on the efficiency of the separator, or should be set aside for hand oiling, or perhaps slushing of cables or chains.

While this procedure may at first appear to be complicated and difficult, a little practice, especially with several oils known to be in different conditions, good and bad, will familiarize the operator with the test, and give him the necessary confidence to rely upon it.

In our plant oils have become unfit for further use after as little as 5,000 hr. of service; yet there is at present in service a 1,000-gal. batch of experimental oil that has had close to 23,000 hr. of service. We use the "batch" system for cleaning, the oil being separated when necessary. During part of the cleaning period the station has been handicapped by a separator that has proved remarkably inefficient. But by continuous watching and with the help of the borax test our oil service compares favorably with that of other plants.



New

FULTON DIESEL

Is Designed for

Mechanical Injection

ANOTHER four-stroke-cycle mechanical-injection Diesel to make its appearance is that built by the Fulton Iron Works Company. This company has built air-injection Diesels since 1915, but decided that for capacities up to 500 hp. the mechanical-injection principle, by reason of the simplicity of construction, was the more desirable. This led to several years of experimenting, which resulted in the present design. The Fulton engine has a bore of $13\frac{1}{8}$ in. and a stroke of 18 in., which at 300 r.p.m. gives a cylinder unit rating at 65 hp. This is 70 lb. mean effective pressure referred to brake horsepower, a moderate value for engines using a plain combustion chamber. The engine is made in sizes ranging from two to eight cylinders.

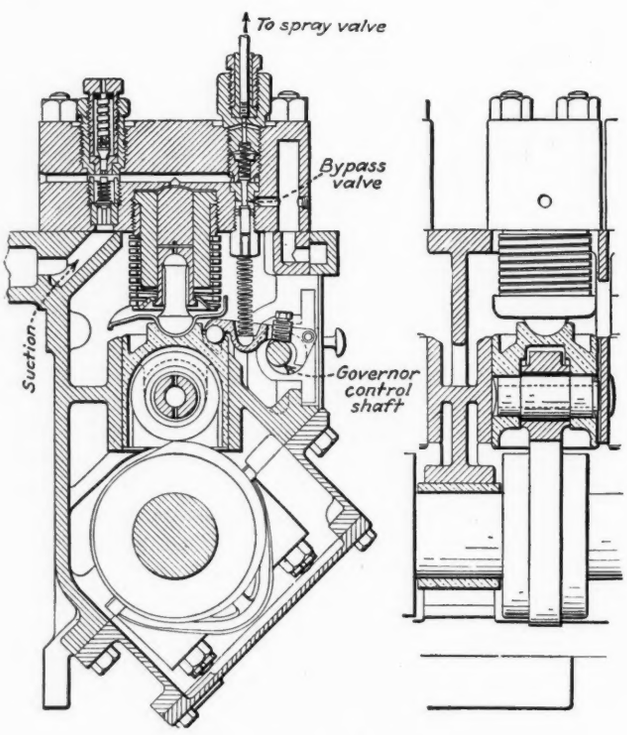
The frame is identical in design with that used on the Fulton air-injection engine, and consists of a one-piece bedplate supporting the shaft, and an embloc frame in which are inserted the cylinder liners.

The crankshaft is an 8-in. solid forged shaft with large bearing surfaces. The connecting rods are also round-section forgings, of open-hearth steel, fitted with marine-type crankpin boxes. These boxes have removable babbitt shells held in cast-steel upper and lower halves. The halves are held together with two loosely fitted special steel bolts. Male and female joints on the upper and lower halves insure alignment of the crank box with the loosely fitted bolts, which prevents crystallization.

The crankshaft rests in removable shells of solid babbitt, designed to avoid the use of cast-iron backs. This feature permits a free expansion of the babbitt while the engine is in operation and insures a close contact of the babbitt with its supporting housing.

At the level of the cylinder heads the camshaft is driven by a vertical shaft and helical gears. All cams are chilled cast iron, clamped to the shaft in such a manner that adjustment is easily made.

The governor is mounted on the flywheel end of the frame and is driven from the crankshaft. This position eliminates the torsional disturbances which sometimes exist when the governor is placed at the shaft's free end. Its control shaft runs

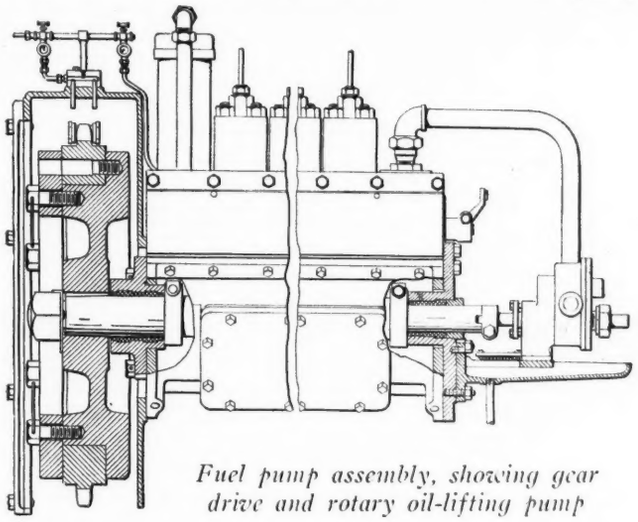


Cross-section of fuel pump

along the engine frame to the fuel pump at the other end.

Simplicity marks the fuel-spray valve, which embodies features of importance to solid-injection engines. The needle is guided and lapped into the nozzle body, which secures absolute alignment of the needle and its seat and at the same time prevents the needle from binding and sticking. The nozzle has several openings, which makes it possible to distribute the fuel uniformly throughout the combustion chamber. Openings are of relatively large sizes (being approximately four times bigger than the openings in the fuel-oil strainer), thus eliminating clogging.

The fuel pump is mounted on the front end of the engine and is driven by a silent roller chain. The chain has hardened pins and rollers throughout, ground within very close limits. The pump body is made of open-hearth forging, with removable and hardened valve seats and hardened valves. Pump plungers and liners are ground and lapped into each other, while the liners are held to the pump body by gland nuts and can be removed easily. Valves, seats, plungers, and liners are all made of stainless steel. Each cylinder has its individual pump



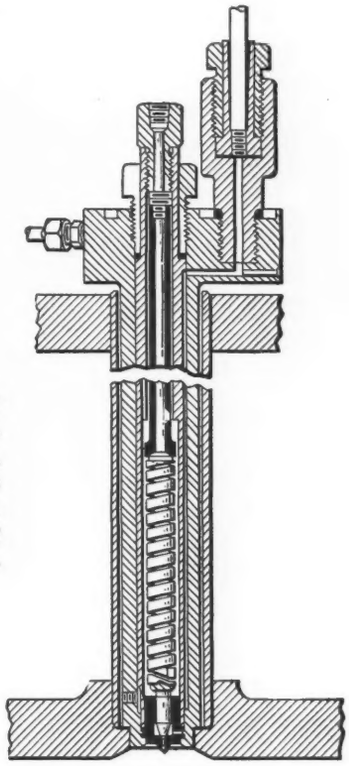
Fuel pump assembly, showing gear drive and rotary oil-lifting pump

body, which can be conveniently and quickly removed without loosening any pipe connections with the exception of the small fuel pipe leading from the pump to the fuel-spray valve.

Cams and cam rollers, both hardened and ground drive the pump plungers. The motion from the cam roller to the plunger is effected in such a way that the latter cannot bind and stick. Surplus fuel oil furnished by the pump is bypassed by a valve which is under the control of the governor. The opening and closing of each bypass valve can be adjusted individually, so that each cylinder gets its proper share of fuel and load. This adjustment is very simple and can be accomplished while the engine is running.

The pump housing has a horizontal partition, the lower compartment being completely filled with lubricating oil, submerging the cam shaft, bearings, cams, cam rolls and their guide. This not only secures effective lubrication of the moving parts, but aims to prevent their heating and sticking, as the oil in the lower compartment of the pump housing is in connection with the forced-feed lubricating system and is continuously renewed. The upper part of the camshaft housing is designed so that any dripping or leakage from the fuel pump is caught and prevented from mixing with the lubricating oil of the pump.

The camshaft of the fuel pump is extended, and at its forward end drives the rotary pump which supplies the main fuel pump. Fuel passes through a strainer having openings not exceeding 0.0035 in. before entering the



Section through the spray valve, which consists, essentially, of a spring-loaded needle valve and a five-hole orifice

fuel pumps. This prevents grit or other impurities from coming in contact with the pumps, plungers, valves, etc., which would cause operating difficulties.

The power cylinders are lubricated by separate metering forced-feed pumps. The oiling system of the cylinders is thus entirely independent and distinct from the bearing lubricating system. Two feeds are used for each power cylinder.

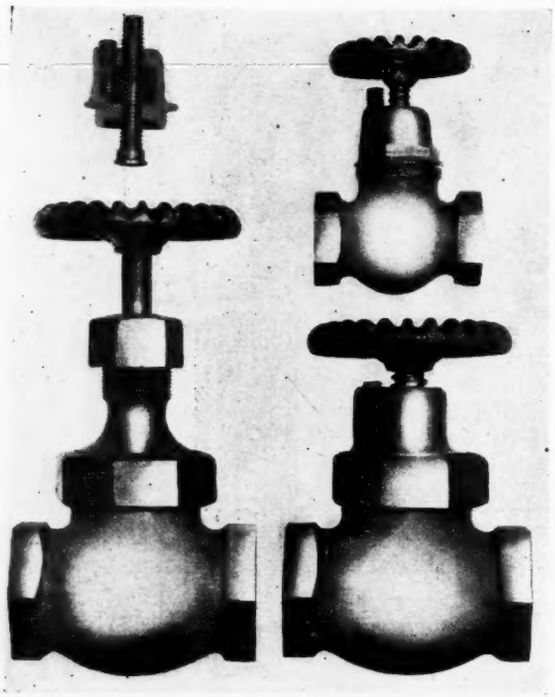
Main, crank-pin, and piston-pin bearings are supplied by a circulating pressure system through drilled crankshaft and connecting rods. Oil drains from the crankcase into the sump tank, from where it is drawn by a gear-type circulating pump after passing through a strainer inside sump tank. From the pump the oil is delivered into the various bearings under a pressure of 10 to 15 pounds.

Air Cylinder Lubrication

TO BEST EFFECT air-compressor lubrication, each cylinder should be equipped for forced-feed or pressure lubrication, whereby uniform and measured quantities of oil can be fed regularly; in the first stages, according to *Lubrication,* only a drop or two a minute will be necessary.

The third, or last, stage will usually be abundantly served with oil carried up from the preceding stages. But no hard and fast rule can be laid down in this regard. The safest course to follow in determining upon the quantity of oil to use is to remove the valves at periodic intervals and examine the cylinder walls. A properly lubricated wall should be coated with a film of oil which will just barely dampen or stain a cigarette paper.

Right Out of the Plant



New method of packing reduces length of bonnet and stem

Simplified Valve Construction

AS INDICATED in the upper left-hand view in the illustration, the valve hub or bonnet assembly has been unified. This eliminates the packing gland or follower and the packing nut which are necessarily required in the conventional type of valve.

The packing is inserted at the threaded hole, near to and parallel with the valve stem or spindle, and is compressed with the screw, which is turned with a piece of hexagon rod or wrench inserted in its hollow end; if a slotted headless set-screw is used, the packing is tightened with a screw driver. Little force is required at the wrench or screw driver to compress the packing to the required maximum pressure against the threads of the valve stem. Unlike the ordinary type of valve, tightening or adjusting the packing does not change the amount of sealing surface or contact between the packing and valve stem or spindle.

The threaded-through portion of the bonnet, both at the upper and lower ends, provides a pair of bearings or large rubbing surfaces that maintain valve-stem alignment within close limits. A screw thread is cut over the entire length of the stem and screws through the packing as if it were a nut.

Any substance leaking out between the packing and the threaded valve stem would have to travel twice as far over the sealed area as it would if the stem were not threaded, because of the "hill-and-dale" effect of the threads.

In response to requests for criticism on this design, it is invariably suggested that the screw threads on the stem in contact with the packing would rapidly tear it to pieces. But if the thread surface is as smooth as that of the unthreaded portion of the usual type of valve stem, there should be no difference in the amount of wear on the packing under like conditions.

The valves have been tested for some months under a pressure of 150 lb. of steam using a commercial brand of flake metallic packing.

Inasmuch as a standard make of valve and packing are used in connection with this arrangement, it seems there is little to be learned from a test. If there is anything in favor of this change in construction it is because it is cheaper to make and easier to pack, there being no way of getting the packing in wrong. The screw always forces it to the proper place. As shown in the photograph, there is a noticeable difference in the length of the bonnet and stem as compared with the standard type of valve.

P. J. McCULLOUGH.

St. Louis, Mo.

Correct Value of Air Temperature in Calculating Heat Losses

THE A.S.M.E. test code specifies that t should represent boiler room temperature in finding the stack losses by using the expression $(T—t)$. But from the variety of reasons given by those who express their opinion in favor of using the boiler room temperature, there seems to be considerable confusion as to the reason *why;* so that there appears to be a possibility that all, including the A.S.M.E. Test Code Committee and those advocating the outside temperature, may be wrong.

In the discussion on page 1018 of *Power* of Dec. 24, 1929, G. V. Williams states the proposition correctly when he says: "In calculating a heat balance, the purpose is to balance the heat delivered to the furnace, which is in the form of coal, plus the heat in the feed water, plus the heat in the air for combustion, against the heat lost into the steam, flue gas and radiation."

More clearly expressed: The potential heat of the fuel fired, plus the sensible heat in the fuel and air supplied for combustion, plus the heat entering the boiler with the feed water, must balance the heat in the steam produced, plus the sum of all the heat losses. In short, the heat input must equal the heat output.

The only logical reason for deducting the heat brought to the furnace by the air from the heat lost up the chimney is that it is available without cost. Admitting for the moment that that is a good reason, the question is, should t be the temperature of the air inside or outside of the boiler room? The heat in the air supplied to the furnace from the boiler room consists of two parts: (a) the heat in the outside air, and (b) that due to the increase in temperature of the inside air caused by radiation from the boiler setting and steam pipes. Since the combustion of the fuel is the source of b, it is quite logical that it should receive credit for that amount of heat; and since a costs nothing, it is at least plausible that it should be lumped with b and credited to the fuel.

This would seem to prove that t should represent boiler room temperature. So far so good; but is the true effect of the air temperature on boiler efficiency

correctly solved by using the factor *(T—t)* in calculating the heat carried to waste up the chimney?

In establishing a heat balance, all the heat contained in the feed water is added to heat in the steam, which is scientifically correct, because it goes directly to the boiler without appreciable loss. By using the factor *(T—t)* the sensible heat contained in the air and fuel consumed is deducted from the heat loss, and since the heat input must equal the heat output plus the total heat loss, to maintain the balance, the heat credited to the steam must increase as much as the heat loss is reduced. It is evident, however, that only from 60 to 80 per cent, depending on the efficiency of the boiler, of the sensible heat in the fuel and air is absorbed by the boiler. Is it, therefore, scientifically correct to credit efficiency with 100 per cent of this heat when 20 to 40 per cent of it is lost up the chimney? If XT, the total heat in the dry gas $- Xt =$ the sensible heat in fuel and air, would it not be the scientifically correct thing to add Xt to the potential heat of the fuel instead of deducting it from the heat loss?

ED. A. UEHLING.

Milwaukee, Wis.

Useful Curves for Pump Calculations

WHEN computing tank capacities, pump requirements and other hydraulic problems it is necessary to allow for the variation of the density with the temperature of the water.

At ordinary temperatures (60 to 80 deg. F.) 500 lb. an hour corresponds to 1 gal. a minute. This is a useful convertion factor and one that is easily remembered. With increasing temperatures this factor decreases materially, as shown by Fig. 1. Gallons per minute multiplied by the value of X_1, corresponding to the temperature of the water, will give the corresponding rate of flow in pounds per hour with a fair degree of accuracy.

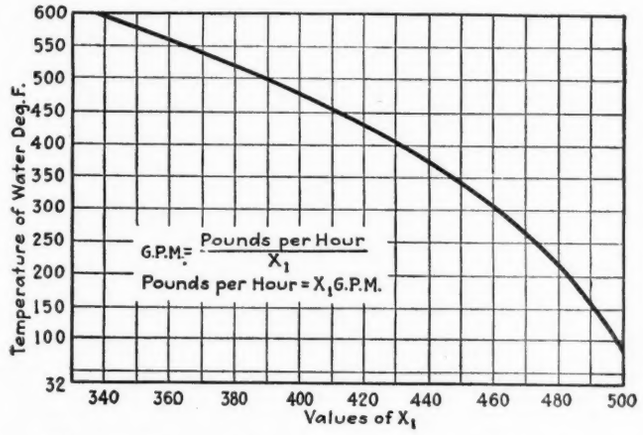


Fig. 1—Curve shows value of conversion factor, at various temperatures

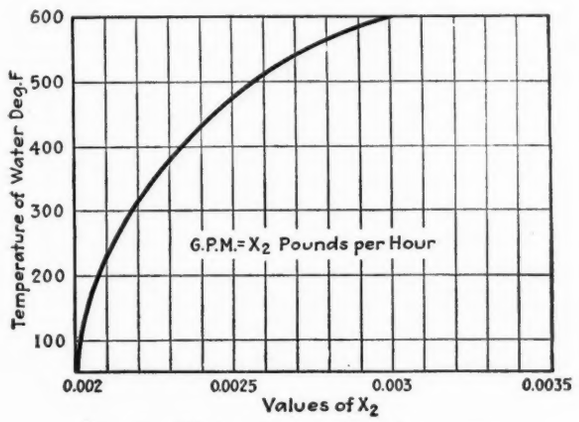


Fig. 2—Water-flow conversion curve

Since it is usually much easier to multiply than it is to divide, the reciprocal of the factor X_1 is quite handy for converting pounds per hour to gallons per minute. Values of X_2 (reciprocals of X_1) have been plotted against temperature for Fig. 2. Gallons per minute $= X_2 \times$ pounds per hour.

Pressures in pounds per square inch are converted to feet water at ordinary temperatures by multiplying by 2.31. Values of the multiplier for temperatures above 80 deg. F. are shown in Fig. 3.

PAUL W. ANDERSON.

New York City.

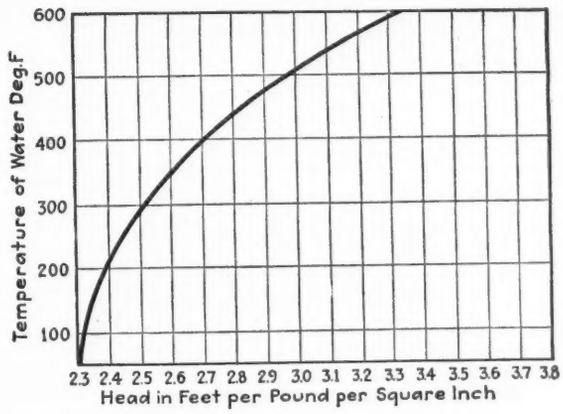


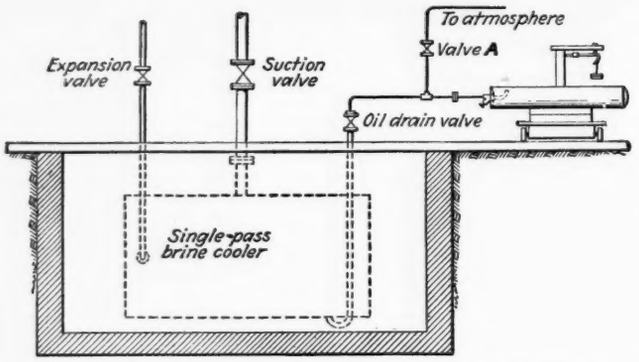
Fig. 3—Water-pressure conversion curve

Practical Method of Removing Ammonia From Brine Coolers

IN MAKING a change in the construction of a refrigerating plant wherein a shell-and-tube type of brine cooler was submerged in a brine tank it was necessary to drain the ammonia out of the brine cooler. To do this the method shown in the illustration was used.

An empty ammonia drum is connected as shown and placed on a platform scale. The drum is first weighed. Then the scale weights are set at 100 or 150 lb. more than the weight of the drum, according to the size of the drum. The oil drain valve is then opened, and owing to the pressure in the cooler some ammonia is forced over into the drum before the drum pressure builds up to the pressure existing in the cooler. The drain valve is then closed and valve *A* opened and a little ammonia gas is blown off through a pipe leading outside of the building. This will cause a big drop in temperature in the drum and a corresponding low pressure. This condition will exist for a short time, so that after valve *A* is closed the drain valve can be opened and the drum filled with the proper amount of ammonia. A 100-lb. drum is 10 in. in dia. and 7 ft. long, and a 150 lb. drum is 12 in. in dia. and 7 ft. long. Care should be taken not to overcharge the drums, as the gas space may be so reduced as to cause an explosion if the drum should be subjected to high temperatures from normal causes, such as exposure to the sun on warm days.

It is essential that the ammonia drum be connected with the valve pointing downward. This will make the dipper pipe inside of the drum point upward. Then when the valve to the atmosphere is opened, only gas



How ammonia is transferred from cooler to drum

will escape, and the temperature and pressure will both be promptly reduced.

The draining of the ammonia from brine coolers often presents quite a problem, because if the ammonia is pumped out in the form of gas the temperature in the cooler may get so low as to cause the brine to start freezing in the tubes, with consequent dangers of tube rupture. If the brine is cold a pressure cannot be built up high enough to force the ammonia out. It was a set of conditions such as these that brought about the development of the method just described. R. A. WHEATON.

Milwaukee, Wis.

Determining Steam Pressure for Paper Machine Dryer

I WISH to answer the question on dryers that appeared in the Oct. 8, 1929, issue of *Power,* in which the comparative suitability of 45- and 25-lb. steam was asked.

The question suggests two possibilities that might influence the heat exchange within the dryer. The first is reduction of the steam pressure to 25 lb. instead of 45 lb. before the steam enters the dryer. It is necessary to investigate how this further throttling will affect the heat absorption by the dryer wall. This is best accomplished with the aid of a Mollier diagram. By following the throttling effect of 125-lb. steam, 98 per cent dry, to 45 lb. and to 25 lb., the steam conditions at these pressures can be found: showing the steam at 45 lb. to be in a state of practically dry saturation, and at 25 lb. to be slightly superheated.

An article by Professor Nusselt, "The Surface Condensation of Steam," which appeared on page 569 of the January, 1916, issue of *V.D.I.*, showed how to calculate the quantity of heat absorbed by the wall under both of the above-mentioned steam conditions.

According to Prof. Nusselt, this may be computed from the formula

$$Q = \frac{C \sqrt[4]{rs^2R^3(t_s - t_w)^3}}{4n}$$

where Q = Quantity of heat.
V = The latent heat. (With superheated steam, the difference in the total heat of the steam at the two states is to be substituted for V.)
S = The specific weight of the condensate.
R = The conduction of the condensate.
t_s = The steam temperature, deg. F.
t_w = The wall temperature, deg. F.
n = The tenacity of the condensate.
C = A constant based on the volume and internal surface area of the dryer.

In making this calculation, it is furthermore necessary to assume a definite wall temperature, which may vary between close limits only. If this temperature is assumed to be 230 deg. F., the formula will show a ratio of 1:0.85 between the quantity of heat absorbed at 45-lb. pressure and that at 25-lb. pressure.

From this it appears that if the steam remains stationary inside of the dryer the heat transfer to the walls will be decreased by further throttling below 45 pounds.

This does not hold true, however, if the steam is in motion. Professor Nusselt also developed a formula for this case, which assumes that the steam propels itself in the same direction as the film of condensate that flows from the walls. It shows that the heat transfer may be increased several times over if the steam is in motion.

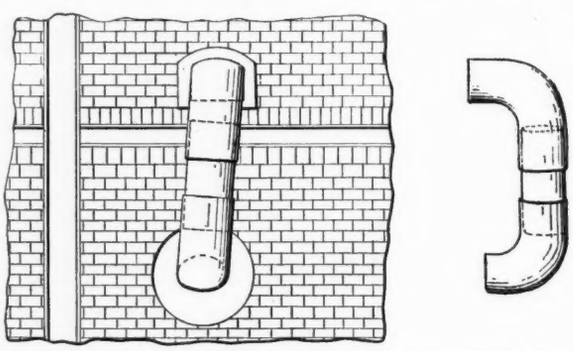
Munich, Germany. G. ACKERMANN.

Simple Method of Cooling Bent-Tube Boilers Equipped With Induced-Draft Fans

IN A RECENT number of *Power* there was illustrated and described a manhole exhauster such as would be used to cool off boilers or to circulate air through the drums while they were being cleaned. Unfortunately, we all cannot have such equipment, because of the first cost; so other methods of doing this have to be devised.

In boiler plants where forced and induced draft is being used, a device that has proved satisfactory is shown in the illustration. It consists of a piece of galvanized iron pipe and two elbows, one of which is placed in the lower drum manhole and the other in the nearest door in the setting. When the pipe is in place, the firedoors are closed and the induced-draft fan started. This causes air to be drawn in at the manholes in the upper drums, down through the tubes to the mud drum and out through the fan to the stack.

I have used this method for at least six years and find it to work satisfactorily, with no effects on the boiler settings. We can take a boiler out of service at 12 o'clock midnight and enter it at 8 a.m. the next morning. Of course, after the steam is blown out the water is



Sheet-metal pipe connects mud-drum manhole with nearest door in boiler setting

changed during the night. A connection of this kind would be harder to install on a horizontal return-tubular boiler, on account of longer connections to the boiler setting, but it could go in the firedoor. I know of one case where it gives good results in a plant having natural draft. E. H. KIRCHNER, *Chief Engineer,* Mississippi Valley Public Service Co.

Winona, Minn.

FROM AMONG READERS' PROBLEMS

Conducted by
L. H. MORRISON

FIGURING BOILER EFFICIENCY—*We burn oil under our boilers, and for a given period our records are: Steam, 3,398,600 lb., oil, 210,416 lb.*

The oil company gives the B.t.u. as 18,250. Our boiler pressure averages 90 lb., and our feed water approximately 160 deg. F. According to my figuring, we are getting a little better than 16 lb. evaporation and an over-all efficiency of about 79. If I am incorrect, please give me the correct figures. N.N.

The feed water entering the boiler at 160 deg. F. contains 127.86 heat units per pound, measured from water at 32 deg. F. Steam in a dry saturated condition at 90 lb. gage contains 1,187.2 heat units per pound above water at 32 deg. F. The difference, 1,187.2 — 127.86 = 1,059.34 B.t.u., is the heat absorbed from the combustion of the oil per pound of steam.

You state that you evaporated 3,398,600 lb. of steam, so the boiler has absorbed from the oil, 3,398,600 × 1,059.3 = 3,600,136,980 B.t.u. The 210,416 lb. of oil contains 210,416 × 18,250 = 3,840,092,000 B.t.u. The efficiency of the boiler is then 3,600,136,980 ÷ 3,840,092,000 = 93.7 per cent. This is too high a value, so either your oil consumption figure is too low or the steam too high.

BURNING HOGGED FUEL—*In our plant we burn hogged fuel in combination with coal. We find that if we increase the ratio of coal to hogged fuel, the chimneys smoke badly, and at a decrease in the ratio the smoking stopped. Why is this?* C.F.R.

When dry fuel is burned in large quantities in connection with green fuel, the extra draft required for the green fuel picks up some of the dry fuel in suspension and also keeps the furnace temperatures down, so that some of the volatiles in the dry fuel are not completely consumed before they reach the stack. This results in smoke. You, of course, appreciate that visible smoke is the carbon from incomplete combustion of the hydrocarbons and not the result of incomplete combustion of the fixed carbons.

USE OF NATURAL GAS—*How much is natural gas used as fuel in public utility plants?* P.R.B.

More than 10 per cent of all the fuel used in public utility power plants is natural gas, this amounts to over 10 billion cubic feet per month. Two Southwestern states, Texas and Louisiana are responsible for over half of this consumption.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

ARE water-wall furnaces justified in an industrial power plant when the plant runs but 10 hr. daily and the hourly output varies from 25,000 to 60,000 lb. of steam?

THE ANSWER to the question is, in my opinion, definitely "no." As reference is made only to the load and load factor, all questions relative to the necessity of producing 60,000 lb. steam in a space allotment sufficient for only 20,000 lb., the fusibility of the ash, the purity of the feed water and the intelligence of the operators are waived. So the discussion is simply a matter of dollars-and-cents return. Here are the required, and, I hope, reasonable, assumptions to solve the problem.

An all-refractory setting with fairly good coal, and a combustion chamber designed for a maximum of 30,000 B.t.u. per cubic foot for stokers, and 13,000 B.t.u. for pulverized fuel can be operated efficiently and with low maintenance. Such a boiler would absorb about 8,500 B.t.u. per sq.ft. of heating surface, or evaporate 8.5 lb. of steam per hour. The boiler for 250 lb. pressure would cost delivered and erected $2.35 per sq.ft. The total cost for the 7,000-sq.ft. boiler would be $16,500. Installing 600 sq.ft. of water walls, a reasonable amount, with an average absorption of 30,000 B.t.u., would permit the reduction of the boiler to 5,000 sq.ft. for the same boiler heat absorption. Water walls are cheap at $20 per sq.ft., so the total cost of heating surface will be $23,750.

Operating at from 25,000 to 60,000 lb. of steam per hour for the 10 hr., an average of 45,000 lb. per hour is the maximum to be expected. With the all-refractory setting an efficiency of 73 per cent can be maintained on 13,700-B.t.u. coal. This means a consumption of 6,750 tons per 3,000-hr. year, costing about $25,000. With equivalent furnaces, there might be a saving of a maximum of 4 per cent of the fuel, amounting to $1,000 per year. Compare this saving to an annual charge of $1,080, which is 15 per cent on the cost difference between the two boilers.

Some of your readers will raise the point of maintenance. With the rates of release that I have used the annual furnace maintenance on a properly designed and built all-refractory setting should not exceed $100 a year—in fact it should be considerably less. Water-wall advocates, what are your maintenance costs, tube replacements and cleaning included?

THEODORE MAYNZ.
Consulting Engineer.
Cleveland, Ohio.

EVERY BOILER FURNACE is water cooled, by the boiler, and whether further tubes should be added depends upon the economic handicap imposed by fuel, refractories, setting limitations and load demand.

Pulverized coal is best adapted to the off period of fourteen hours per day at this plant. Many types of coal permit carrying satisfactory CO_2 without such high furnace temperatures as to endanger the refractories. In other cases, the change from a cheap coal of low fusion point to a more expensive fuel would be more economical than the use of water walls. It might be found cheaper to operate two boilers at low ratings with plain refractories and poor coal than to attempt doubled ratings on one boiler with water walls. The part that local details play in this problem is obvious. However, there remain many cases where the economical plan is to water-cool the furnace. A forced-circulation water wall using small-diameter tubes which can readily be bent around corners and applied in any direction will be found cheapest to apply and most generous in its results, even when the power required for circulating pumps is debited.

The shape of furnace, placement of tubes, shape and nature of flame all play a part in the matter of combustible in the refuse. Not every boiler will give lower final flue gas temperatures when the gases are first exposed to water walls. The furnace design and boiler baffling should be checked with this in mind.

A water-cooled furnace can operate at high ratings efficiently, yet subject the refractories to lower furnace tempera-

tures than a plain furnace. The range of temperature between banked condition and maximum rating is thus reduced and the life of the refractories prolonged.

There is also the advantage of increased rating from the furnace and boiler, and water walls may be cheaper than a second boiler.

Against these advantages must be balanced cost of bare water walls, of setting changes to accommodate them, of feed-water treatment, of water-wall maintenance, of forced-circulation pumps, and of power. It must also be considered whether the average load is consistently high, or whether the short periods of high load could be carried best by temporarily decreasing the CO_2.

Water walls give the best results in connection with those pulverizers and burners that provide maximum furnace turbulence and a constant fineness of pulverization.

JOHN F. KYES, JR.,
Riley Stoker Corporation.
Worcester, Mass.

THE PRIME FUNCTION of water walls is to reduce furnace maintenance, but certain definite limitations exist, which seem to apply in this particular case.

The initial cost of water walls is high. Unless the boiler and furnace are of sufficient size to permit operating at high ratings, the fixed charges will more than offset the savings in maintenance.

In the case of 60,000 lb. maximum steam demand, such a load in an existing industrial boiler house is normally divided among a number of small boilers of 2,500 or 3,500 sq.ft., which would not warrant the use of water walls.

However, if the entire load is carried on one boiler of about 5,000 sq.ft., the expenditure for water walls is probably justified.

It is to be noted that in new plants the cost of water walls is written off due to high ratings permissible on individual units, cutting down the number of boiler units required and saving on the building cost as well.

The questioner should bear in mind that many other things enter into the consideration, including the method of firing and type of fuel.

T. W. WELSH,
Thomas E. Murray, Inc.
New York City.

THE PAUCITY of the figures given and the many possible local conditions precludes anything but a most general discussion of this problem.

A first impression is that water walls would not be worth-while for any plant operating only 42 per cent of the day. However, in practically all cases, the fundamental purpose of water walls is to increase boiler capacity. Heat saving is secondary. Radiant heat-absorbing surface is eight to ten times as active as boiler convection surface, and water walls can easily pay for themselves in the saving in boiler surface.

The higher combustion rate possible in a water-cooled furnace permits it to be smaller, with various attendant savings. Brickwork maintenance, a considerable item with much stopping, starting and load fluctuation, is reduced.

The smaller heat storage in a water-cooled furnace reduces banking losses for oil or pulverized coal, gives quicker response to fluctuating loads, and permits quicker starting in the morning.

Since a maximum demand of 60,000 lb. per hour is large for an industrial plant, it would be worth-while to consider ways to reduce boiler plant investment. Offhand, water walls seem justified for this installation.

R. H. SOGARD.
Topeka, Kan.

SINCE the question does not state whether the peak load will be carried for long or short periods, or the characteristics of the fuel, answers can only be general.

Should the peak load of 60,000 lb. of steam per hour occur quite often it will probably pay to equip with water walls to get high efficiency by high CO_2 and low excess air.

On the other hand, should the peak load occur only occasionally, it will most likely be better to run at lower CO_2 for its duration, keeping furnace temperature down by more excess air, and do without water-cooled walls.

The gains effected by the water-cooled walls, such as control of furnace temperature and less upkeep, must be carefully balanced against the high first cost of this type of construction in comparison to boiler surface or refractory walls. This, of course, is dependent on the size of the unit, which, in turn, is governed by the occurrence of the peak load.

W. J. FASSBENDER,
Yarnall-Waring Co.
Philadelphia, Pa.

FROM an investment standpoint, the use of water walls is justified in almost all cases in plants above the horizontal return-tubular class. The higher rates of heat release per cubic foot of furnace volume obtainable with water-cooled furnaces allow higher boiler ratings to be carried. Consequently, smaller boilers can be used, with a saving in boiler, building, and refractory investment. The cost of water walls in a properly balanced installation is more than compensated for by the saving in these three items.

Consider the case in question, using, first, three 5,000-sq.ft. refractory furnace units, with two operating at 200 per cent to carry the 60,000-lb. steam load and as an alternate three 3,500-sq.ft. water-cooled units, with two operating at a maximum rating of 286 per cent. A comparison of approximate investment cost per boiler is:

	5,000 Sq.Ft. Refractory Furnace Unit	3,500 Sq.Ft. Water-Cooled Furnace Unit
Boiler	$12,500	$9,000
Setting	6,200	5,500
Building	6,400	5,300
Water walls	.....	5,300
Total investment per boiler	$25,100	$25,100

The allowance of $5,300 for water walls in the smaller units will more than provide wall coverage for the additional rating required. The higher rating will yield slightly higher outlet-gas temperatures, but this will be offset by lesser banking and radiation losses.

ALBERT E. CANFIELD,
The Strong-Scott Manufacturing Co.
Minneapolis, Minn.

IT WOULD APPEAR that with such a large variation in load the adoption of water walls would be advisable, especially if the load variation is rapid.

That would enable the boiler to carry the 60,000 lb. per hour at from 150 to 200 per cent rating without heavy maintenance charges, and in addition the water walls would give greater flexibility.

A boiler with a normal steaming capacity of approximately 40,000 lb. should carry the load efficiently.

The capital cost should be about the same as that of a boiler without a water-cooled furnace, for with the former the combustion chamber would be smaller and the amount of heating surface in the boiler considerably reduced.

However, the water cooling should not be overdone, because with pulverized fuel firing a very narrow boiler will result in flame impingement on tubes and walls, and incomplete combustion will occur, especially with low-volatile coal.

T. H. PARDOE.
Wolverhampton, England.

I DO NOT THINK water walls justified, because of the 10-hr. operating time. The furnace would have too much time to cool down, and a water-cooled furnace would require much more fuel to heat it up again in the morning than would a brick-wall furnace. If the power plant were running 24 hr. per day, with a high furnace temperature, water-cooled walls might be satisfactory.

JOHN L. WHITE.
Lima, Ohio.

A Question For Our Readers

WHAT is the best furnace arrangement for burning hagged fuel in conjunction with pulverized coal—pyramid grates, flat grates, refractory hearth or water-tube furnace floor? G. R.V.

Suitable answers (of 200 words or less) from readers will be paid for and published in the Feb. 25 issue.

Regional Organization . . . *the Key to* Economic Stability

WHILE THERE are in this country excellent national organizations for the promotion of economic stability and progress, and while there are many local community industrial and commercial bodies serving the same purposes, there is, with one exception, no semblance of regional organization. This despite the fact that the United States, as shown by extensive surveys of the Department of Commerce, is divided naturally into nine economic regions, and many of the most important problems business has to solve can best be attacked by regional action.

One section of the country, however, has such an organization—the New England Council—and its success in encouraging industrial stability and progress within its sphere unmistakably shows that other natural economic divisions of the United States could well profit by the establishment of similar councils. Such bodies would form a bridge between national and local associations, would serve the special needs of each economic area, and would provide machinery for carrying out sound economic programs designed by national leaders for the country as a whole.

A brief summary of some of the important achievements of the New England Council during the five years of its existence will serve to illustrate the value of regional organization. Drawn from the recent remarkable annual report of the council, it follows:

Agriculture

First of all, the council undertook the task of rehabilitating New England's farms. Production and consumption of farm products were exhaustively studied. Departments of Agriculture in the six New England states co-operated in preparing a definite farm-marketing program for the farmer. Legislatures passed uniform laws covering the grading and labeling of farm products. New Englanders were urged to buy farm products with New England labels, with the result that today New England supplies a greater proportion of its total consumption of farm products than in several generations.

Industry

Soon after its formation the council attacked the problem of checking any possible decadence in industry, to make certain that the region would maintain its position of importance. Believing that a manufacturer was only as strong as his research facilities, the council assigned important men to the task of making New England "research conscious."

Under the impetus of the Research Committee, a stock-taking survey of the whole region was inaugurated. Available natural resources were inventoried. Industrial establishments were classified. Local markets for regional products were determined, and retail and wholesale trading areas were charted. A special study, to determine the steps taken by banks in broadening their services to industrial customers, was financed by 324 commercial banks throughout New England.

Eventually the Research Committee had at its command invaluable data on the various units which combined to form New England's business and economic structure. In innumerable instances the committee's reports inspired definite action which brought important and beneficial results.

Power

The council began its work in this field by engaging competent engineers to prepare a complete map showing all existing and projected power transmission lines in the six New England states.

Industry and power are so closely interdependent it is almost inconceivable that one could develop without directly affecting the other. Expansion of industry calls for more power, while increased efficiency in the production and application of power inevitably stimulates industrial growth. Any far-reaching plan for the development of one, therefore, is bound to concern the other. Such a plan now demands consideration from leaders of both—a plan for the promotion of economic balance by the organization of councils for the natural economic divisions of the country.

Recognizing the interstate transmission of power as an accomplished fact, and with the encouragement of the council, the power companies established definite standards of practice to which the various utility companies subscribed. Then the council's Power Committee induced the power companies to accept joint jurisdiction of State Public Utilities Commissions in all controversies over rates on power transmitted across state lines.

The council created a special committee to promote the extension of power lines into rural territory and to determine a basis for arriving at a fair and equitable charge for current. The committee carefully studied the situation, and recommended basic principles of procedure and a formula for arriving at a proper rate. The recommendations have already been adopted and successfully used by some of the larger power companies. Among them is the Central Maine Power Company, which in the last three years has built approximately 450 miles of new lines, serving about 3,000 rural customers. Similar results, due largely to the activities of the council, have been obtained in other New England states.

Briefly, the value of the various power committees of the New England Council is shown by the fact that New England, with 6.9 per cent of the country's population, has 8.6 per cent of the generating capacity and total number of customers.

Community Development

In working for the general welfare of the region, the council decided on definite procedure only after definite knowledge had been obtained by the general survey in which 5,000 leaders in all the important communities took part. Results were classified and analyzed, and remedies suggested.

Today, more than fifty industral development committees are actively cooperating with local chambers of commerce for the upbuilding of industry in their respective communities. In fifteen cities special industrial bureaus have been established. Several cities have raised industrial development funds ranging from $300,000 downward. Special personnel was assigned by 104 power companies to the work of community upbuilding. Within one year of this campaign, 431 new industries were established in 197 communities, employing 11,000 persons. Forty of these were branch factories.

The greatest achievement of the New England Council, however, is not reducible to statistics. It cannot be shown in a graph. The greatest thing it has done is to put new spirit into New England. Where there was discouragement, almost despair, where there was no unity, where governors of the six states and the presidents of the railroads did not know one another—the council has created a spirit of unit, of hope, of confidence, of drive. It is hard to tell how much of the progress in New England is due to this new spirit.

As suggested in a recent issue of the *Business Week*, it is now up to the leaders in other areas to take the plan New England has provided and create living, functioning, vitalizing organizations of a similar type and similar value in their own separate economic regions.

WATER OR STEAM POWER?
. . . *The Economics of the Question*

BY GEORGE A. ORROK*
Consulting Engineer

THE economics of water vs. steam power is, so long as the coal supply is assumed to be practically inexhaustible, purely a question of the costs of power production and distribution from its source to the market.

In considering these two sources of power, we shall assume electric generation and transmission, for in this way alone can the product of most water power plants be brought to a profitable market. Two centuries ago we used overshot wheels and transmitted the power a maximum distance of about 100 ft. Today our major systems of electrical supply are linked up with ties and so interconnected that on one occasion a year ago the entire eastern portion of the United States, from Boston, through Chicago, to Pensacola, Fla., was connected up, synchronized, and run as a single system for about thirty minutes.

First let us consider the water-power side of the question. The cost of the water power plant will include the cost of the real estate and water rights, the cost of plant construction, the dam, head and tail races, penstocks, surge tanks, turbines, generators, governors, the switchboard, and the cost of the transmission line. The cost of the water power will include interest, depreciation, taxes, and insurance, plus the operating cost of the power plant, transmission line and substation. Such plants are generally of concrete, massive in construction, with machinery heavy and slow moving, but of high efficiency and long life.

Real estate, water rights and transmission line right-of-ways vary from next to nothing upward, and only a promoter would estimate the cost of hydraulic installations without extensive investigation and surveys. The cheapest hydraulic plant to my knowledge cost about $60 per kw. without transmission, the most costly about $425 per kw. Many investigated sites figure higher than $600 per kw. Transmission lines may cost as low as $7,000 per mile or as high as $100,000. From this widespread field it is evident that to be of any general value calculations must be put in such a form that upon substituting two or more variables, we may find the cost per kilowatt-hour delivered at the market. One of these variables must of necessity be the load factor. A second will be the sum of the fixed and operating costs per delivered kilowatt of demand, or, better yet, the actual prime cost per delivered kilowatt of demand. Such diagrams are easy to construct when the facts are known.

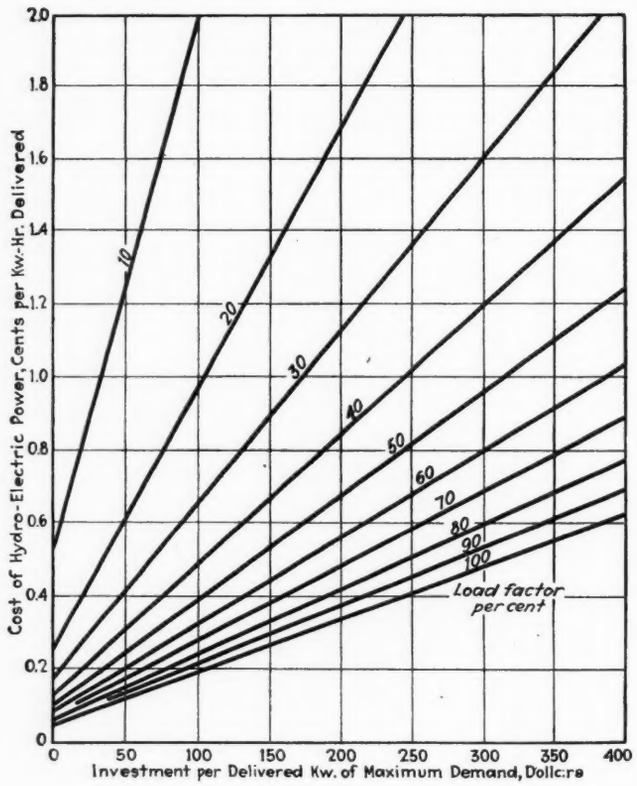


Fig. 1—Cost of hydro-electric power delivered for various values of investment and load factors

Fixed charges, including taxes and insurance, may run from 9 to 15 per cent. From the average of many cases, the operating costs amount to about $2.60 per kilowatt per year, while the transmission operating charge, including the substation at the receiving end, may be taken as $2 per delivered kilowatt of demand per year. One more factor is needed, the loss factor, the ratio between delivered kilowatts and installed kilowatts. Fig. 1 shows such a diagram, the abscissas being the investment per delivered kilowatt of demand, and the ordinates being the cost of a kilowatt-hour, in cents, to which the profit must be added to determine the required price.

When we come to evaluate the cost of steam power, another very different set of conditions obtains. In most cases, the steam generating station is located as close to the center of distribution as possible, once coal supply and condensing water are assured.

The cost of steam stations varies widely, due to market and labor conditions, quality of design, and, to some extent, the steam pressure and expected thermal economy. The lowest cost for a central station built since 1890 of which I have record is about $50 per kilowatt of capacity, while others have cost over $250 per kilowatt. The average cost, leaving out interest during construction, has been about $100 per kilowatt.

Fixed charges could probably be figured at 12½ per cent were it not for the chances of supercession, which are liable to upset any system of depreciation. It seems well to assume fixed charges on the steam plant at 15 per cent, or $15 per kilowatt per year. Labor, maintenence and supplies may be taken as 0.15 cent per kilowatt-hour. The final factor is the cost of coal. This may amount to over 80 per cent of the operating cost, or, with cheap coal, run much lower. The table shows the method of calculating steam costs for the various load factors and with coal varying in price by dollar intervals. The 20 per cent steam reserve sanctioned by good practice is included.

In Fig. 2 the resultant costs have been plotted with load factors as abscissas and total cost per kilowatt-hour as ordinates. Included on the same dia-

*From a paper presented at the World Engineering Congress, Tokio, Japan, Oct. 29-Nov. 7, 1929.

gram, in dotted lines, are the costs of hydro-electric power with various investments per delivered kilowatt of demand. The use of the logarithmic scale gives a more open diagram for comparing the two sources of power. We read, for instance, that for a 50 per cent load factor, with coal at $5 a ton, we can afford to pay about $240 per delivered kilowatt of demand for a water-power installation with its transmission lines, or $100 per kilowatt for a steam station with a 20 per cent reserve installation. Or, if we are considering a water-power plant on which the investment would be $200 per delivered kilowatt of demand at 40 per cent load factor, we could substitute for it a steam station representing an investment of half as much if we could purchase coal at $3.50 per long ton, the cost of service remaining the same. Fixed charges on the water-power plant would be 85 per cent of the total cost, and only 60 per cent for the steam plant.

But this does not tell the whole story. Run-of-stream plants can deliver power up to the low water flow of the stream only. Even with good storage and pondage, or where, as in the Niagara River, the use of water is limited to a small portion of the flow, 85 to 87 per cent is about the best that can be done, because a steady load to secure 100 per cent utilization is not available. In most cases a steam auxiliary is necessary even where both pondage and good storage are found. The variation in kilowatt-hours produced by a hydro plant in wet and dry years is often as large as 50 per cent, and factors of this sort must be introduced suitable to the stream characteristic.

Steam plants, on the contrary, need no such discriminating analysis. Their only serious variations lie in the coal price and the introduction of newer types of equipment, i.e., obsolescence. It may be said that, given a market of a certain type, steam plant costs show smaller variation than water plant costs. A dry year may increase the kilowatt-hour cost of water-generated current 100 per cent, while a 100 per cent increase in coal cost, the only real variable with steam-generated power, would add at best only 30 per cent to the cost of current. This has been shown in detail by Markwart (*Journal of Franklin Inst.*, August, 1927).

Steam plants are self-sufficient. There are many systems, operating without hydro-electric auxiliaries, giving continuous electric service at reasonable cost. Hydro-electric auxiliaries may cheapen the cost, but cannot improve the service. Hydro-electric systems, however, are not usually sufficient in themselves and must use an auxiliary steam supply for four reasons:

1. To give best system economy.
2. For stand-by purposes (failure of transmission).
3. For meeting the seasonal water deficiency during the low-water period on non-regulated streams.
4. For meeting the dry year water deficiency.

Even such aggregations as the Niagara system have a steam reserve to take peaks and meet emergencies, as well as connections to other water- and fuel-power companies through which power may be obtained.

The hydro-electric company is faced with the necessity of restricting its sales to the dry year output, or it must purchase or generate sufficient kilowatt-hours produced by fuel to meet peaks and yearly outputs. Thus the steam reserve has been built up in practically every water-power system. Introduced at first to carry short peaks or handle a cessation of service due to transmission line failures, the steam auxiliary has been extended to meet output requirements in the dry seasons and during years of low rainfall. Then, as the output and demand increase, more and more of the output is carried on fuel until, finally, no more water being available, the fuel plant may carry the bulk of the load, while the hydro takes a subordinate position. If pondage happens to be available, the hydro becomes a peak and stand-by proposition, generating its entire output as daily peaks and only used for a few hours each day. Even with storage to regulate the stream to nearly uniform flow, given sufficient pondage the peak use of water power may be economical.

But there is another limit to the use of water power not included in the economic reasons which have been stated. It is easy to show that the power which would be developed if all the rain falling on the United States were utilized between the level at which it fell and the sea level, would, if it had been generated by steam at 2 lb. of coal per kw.-hr. and 100 per cent mechanical efficiency, represent a coal consumption exceeding the present national coal production by only about 10 per cent.

COST OF GENERATING STEAM POWER

[5 units (one in reserve). Cost of plant complete per kw. = $100. Fixed charges = 15 per cent. Yearly fixed charges = 1.2 x 15 = $18. B.t.u. per kw.-hr. = 13,000 + (100,000/load factor). Lb. 14,000 — B.t.u. coal per kw.-hr. = 0.929 + (7.15/load factor).]

	Load Factor, Per Cent						
	100	80	60	40	30	20	10
Hours utilization	8,760	7,008	5,256	3,504	2,628	1,752	876
Fixed charges per kw.-hr., cents	0.205	0.257	0.342	0.514	0.685	1.028	2.054
Other charges, kw.-hr., cents	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Total charges, kw.-hr., cents	0.355	0.407	0.492	0.664	0.835	1.178	2.204
Coal, lb. per kw.-hr.	1.000	1.018	1.048	1.108	1.167	1.287	1.644
Total cost, cents kw.-hr.							
Coal, dollars per ton (2,240 lb.)	0.400	0.453	0.539	0.714	0.887	1.236	2.277
2	0.444	0.498	0.586	0.763	0.939	1.293	2.351
3	0.489	0.543	0.632	0.812	0.991	1.350	2.424
4	0.542	0.597	0.688	0.871	1.053	1.418	2.512
5	0.578	0.635	0.726	0.912	1.095	1.465	2.571
6	0.623	0.680	0.773	0.961	1.148	1.523	2.644
7	0.668	0.725	0.820	1.010	1.200	1.580	2.718
8	0.712	0.771	0.866	1.060	1.252	1.637	2.731
9	0.757	0.816	0.913	1.109	1.303	1.695	2.865

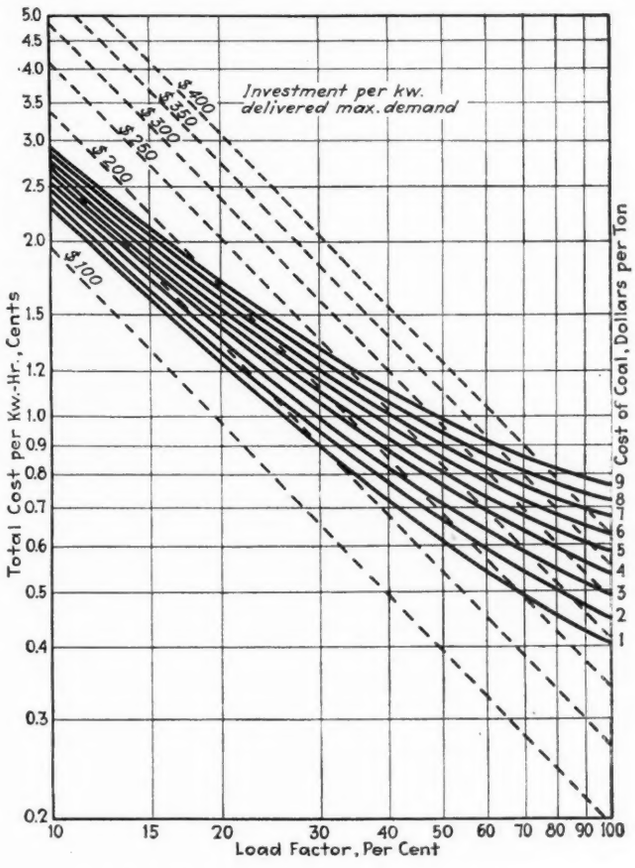


Fig. 2—Comparison of total costs of steam and hydro-electric power

Evaporation and growing vegetation necessarily reduce this total by about one-half. Long nearly flat slopes and subterranean flows account for perhaps 30 per cent more, and the United States Geological Survey estimates a maximum possible output as around 160,000,000,000 kw.-hr., about a 20 per cent utilization of the total rainfall.

The actual survey figures are:

20,700,000 kw. 90 per cent of the time = 163,000,000,000 kw.-hr., or 32,800,000 kw. 50 per cent of the time = 144,000,000,000 kw.-hr.

Proportion of Hydro Power Is Shrinking

We actually have a trifle over 9,000,000 kw. of hydro-electric power installed, which should yield somewhere between 71,000,000,000 and 40,000,000,000 kw-hr. On this installation we actually generated 34,000,000,000 kw.-hr. in 1928. On the same ratio, when all possible plants are built, irrespective of cost, we may expect, roughly, 120,000,000,000 kw.-hr. per year as the maximum possible output from water power. We already use the equivalent of 30 per cent more mechanical power than this, and our central station and industrial generation amounted to about the same, 120,000,000,000 kw.-hr. in 1928. Hydraulic power has been averaging from 33 to 40 per cent of the total, and the proportion will grow smaller as the years go on, with the newer developments becoming more costly and further away from markets.

Meanwhile the output of steam central stations has grown to about 53,000,000,000 kw.-hr. per year and is increasing at the rate of about 10 per cent per year. In 1919 the 24,000,000,000 kw.-hr. generated by steam cost on the average of 3.2 lb. of coal per kilowatt-hour. By 1928 station economy had been so much improved that the average use for the 52,000,000,000 kw.hr. amounted to only 1.79 lb. of coal per kilowatt-hour. More than twenty of the larger stations use less than 1.5 lb. of coal per kilowatt-hour and six are averaging at or about 1 lb. of good coal per kilowatt-hour. We may look confidently towards a further 30 per cent decrease in the use of coal in the central station industry.

Large Units Reduce Generating Costs

Large units cut down the cost of labor, supplies and maintenance, and while, in this discussion, the figure of 0.15 cents has been used, there are numerous precedents to show that this might better be put at 0.08 cents. However, the 0.15 cents more nearly represents average conditions. Units of 100,000 kw. and over are becoming common, and the coming years should show considerable reductions in the figures on operating costs.

Water turbines, on the other hand, are very efficient, 92 to 94 per cent, and the over-all efficiency of hydro plants may be as high as 90 per cent leaving little chance of improvement. With the steadily increasing cost of water rights, real estate, construction and transmission lines, the cost of hydro-electric power will attain higher and higher values, thus shifting the economic balance further toward steam power. This statement is probably true for conditions in the United States notwithstanding the proposed construction of such developments as Boulder Dam and the St. Lawrence Canal, where the power rentals are expected to pay irrigation costs in one case and navigation costs in the other case.

On the Pacific slope, oil is being quoted at $3.60 per ton, while there are sites in the East where $1 coal is available. Thus each proposition is unique, to be considered by itself as to cost, layout, markets, water and fuel supply, rainfall and storage; but when the costs are known it then becomes a question of how long the static condition is to continue. Here the knowledge of the engineer, the genius of the executive, and the judgment of the financier must combine to determine the proper decision.

Natural Gas and Fuel Oil Compared on Heat Basis

By A. Maies
Monterey, Calif.

With the coming of natural gas from Kettleman Hill district, up the Pacific coast, to Monterey, San José and San Francisco, many industrial and domestic users of fuel oil seem to be in doubt whether to continue using oil or change to gas. This is especially true in the Monterey district, where the total daily oil delivery exceeds 2,000 bbl. It is unfortunate that a representative comparison of the fuels in question is not available to the average plant, as it certainly is not to the domestic user.

In most instances dollars and cents is the deciding factor. This is especially true in the industrial plant, where cost per million B.t.u., operating expense, initial cost, and interest must all be considered.

I shall try to set forth in the following a comparison between these two fuels, on an efficiency basis. It is impossible to do this on a price basis, as both fuels will vary in cost according to locality and consumption.

The gas to be delivered is known as a "dump gas," and has the following analysis by volume, moisture free:

Heat content.....1,000 B.t.u. per cu.ft.

Constituent	Per cent
CO_2	0.9
C_6H_6	1.4
C_2	0.01
CH_4	73.3
C_2H_6	23.1
N_2	1.2

When this gas is burned, the reactions are as follows:

$$CO_2 = CO_2$$
$$2C_6H_6 + 15\ O_2 = 12\ CO_2 + 6\ H_2O$$
$$CH_4 + 2O_2 = CO_2 + 2H_2O$$
$$2\ C_2H_6 + 7\ O_2 = 4\ CO_2 + 6\ H_2O$$
$$N_2 = N_2$$

With these formulas corresponding volumes can be figured from the law that volumes are proportional to the number of molecules. Thus in burning C_2H_6 the volume of O_2 will be 7/2 that of C_2H_6, and that of CO_2 will be 4/2 the volume of O_2. Applying this principle, and asuming 100 cu.ft. of this gas at 60 deg. F., we have:

Cu.Ft.	Cu.Ft. O_2 Required	Cu.Ft. CO_2 Produced
CO_2 0.9	....	0.9
C_6H_6 1.4	10.5	8.4
CH_4 73.3	146.6	73.3
C_2H_6 23.1	80.85	46.2

The total quantity of O_2 consumed is 237.94 cu.ft. The CO_2 produced totals 128.8 cu.ft., leaving 109.14 cu.ft. of O_2 consumed by H_2. This H_2 consumed in 100 cu.ft. of gas would then be 1.15 lb., which on reaction will result in 10.34 lb. of H_2O.

If this water would condense and drop into the ash pit, the fuel would suffer no heat loss. Actually it is evaporated and thrown to waste as superheated steam at the stack temperature (say 500 deg. F.), giving a heat loss of 1285 — (60-32) = 1257 B.t.u. per pound of water produced. Multiplying 1257 by 10.34 and dividing by 100, we find that the ultimate loss is 130 B.t.u. per cubic foot of natural gas. This is 11.8 per cent of the higher heating value and reduces the obtainable heat to 970 B.t.u.

The fuel oil in question has a heat content of 18,500 B.t.u. per pound. With 11 per cent of H_2, the loss due to H_2O is $9 \times 0.11 \times 1257 = 1244$ B.t.u. Thus the loss is 6.7 per cent and the net heating value 17,256 B.t.u. per pound. These "lower" heating values should be used in computing the relative heat costs of the two fuels.

Assuming that the efficiency of the two fuels based on the net heat values is about the same, comparison on the basis of the higher heat value gives the oil an advantage of about 5 per cent. In the case of oil, the cost of power for handling must also be computed individually for each plant.

As oil is sold by volume, it is advantageous to the consumer to purchase the lowest gravity (heaviest) fuel he can use. The heavier oils have more heat per gallon, as well as more weight.

A point which should be borne in mind is that, through the process of destructive distillation at the refinery, fuel oils are becoming heavier, which is to the mutual advantage of consumer and refiner. The former gets more heat for his money and the latter a higher price for the lighter fractions.

California leads the 48 states in hydro-electric development, with a total of 2,227,000 horsepower.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

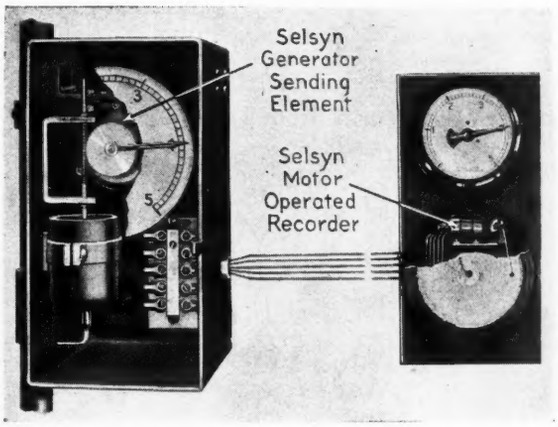


Fig. 1—Selsyn-equipped transmitter with remote indicator and recorder for pressure or liquid level

Selsyn-Operated Devices for Remote Indication and Record

PROBABLY one of the simplest and most satisfactory means of transmitting indications or measurements of rates of flow, pressure, temperature and other factors is by the use of Selsyn motors, which, when properly interconnected, operate so that one motor reproduces any motion imparted to the other.

This principle has been used in a complete line of instruments for remote indication and record of liquid level, pressure, temperature and other factors put out by the Bailey Meter Company, Cleveland, Ohio. The line includes instruments or devices for practically every important application in hydro-electric systems, central stations, water-works and industrial plants.

Inasmuch as the principle of the Selsyn motor is well known, no further mention of it is considered necessary.

To adapt the Selsyn principle to the numerous uses in the fields mentioned, several different types of transmitters have been made available. These consist of pressure, temperature, draft or other actuating elements used to drive the rotor in the Selsyn generator and gear train or other mechanism designed to connect this element with the rotor.

Three types of transmitters are used for remote indication or recording of liquid level. In one a large hollow float rests on the surface of the liquid whose level is to be indicated, and is connected by a counterweighted cable and gear train to the generator. A second type of transmitter for this service is shown in Fig. 1. It employs a steel float resting on the surface of mercury in the open leg of a mercury U-tube so arranged that the generator rotor is driven through a rack and pinion. The actual pressure due to the height of liquid in the tank or reservoir is the actuating medium. For indicating levels in closed tanks or drums under pressure, a transmitter in which the actuating mechanism is a straight-walled inverted mercury-sealed bell is used.

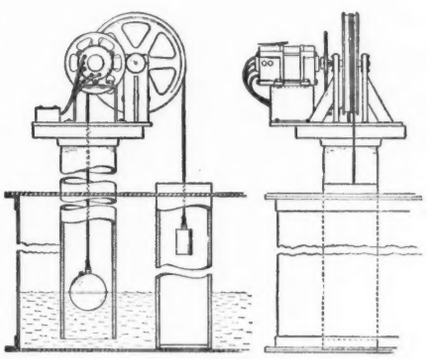


Fig. 2—Float-operated liquid-level transmitter

For long-distance transmission of pressure readings two types of transmitters are available. One is a modification of the unit shown in Fig. 1. It consists of a mercury U-tube with the closed leg of the U-tube connected to the source of pressure, while the other leg terminates in an open reservoir in which a steel float rides on the surface of the mercury. For pressures above 50 lb. the transmitter shown in Fig. 3 is used. It consists of an expansive metallic bellows or sylphon connected to the generator rotor by a gear sector and pinion. When used for pressure, the lower end of the sylphon is connected to the source of pressure rather than to a temperature bulb, as shown.

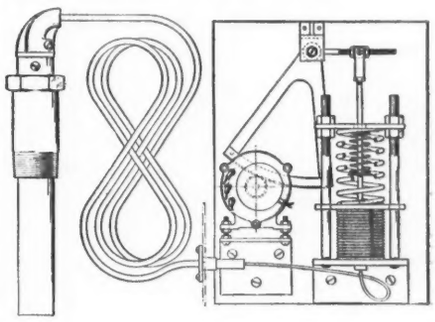


Fig. 3—Temperature transmitter using a metallic bellows

Transmitters to indicate and record vacuum, temperature and drafts are essentially modifications of those already described. Miscellaneous types are also available for indicating the position of dampers, sluice gates, valves and similar equipment.

A standard indicator and recorder for use with the transmitters is shown at the right in Fig. 1. Several types and sizes of these are available to meet the needs of the installation.

Combination Burner for Standard and Waste Liquid Fuels

A COMBINATION BURNER designed especially for certain waste fuels alone or in combination with standard fuels has been added to the line of burners for oil and pulverized coal put out by the Peabody Engineering Corporation, 110 East 42d St., New York, N. Y.

Among the liquid waste fuels this burner is designed to handle are 100-deg.-melting-point petroleum pitch and heavy residues, acid sludge, neutralized sludge and acid tar. The burner is of the mechanical atomizing type with a wide-range system of control, which it is claimed, permits

Burner with insulated front

various capacities without sacrificing fineness of atomization. It is also possible to circulate a larger quantity of fuel through the burner than will pass through the nozzle. This permits larger passages in the tip and reduces the possibility of plugging. Furthermore, the fuel is kept in continuous circulation through the burner, preventing the solid matter from settling out. Fuels containing as high as 30 per cent base settlings and water and 5 per cent sediment by extraction are being handled by the burner, it is claimed.

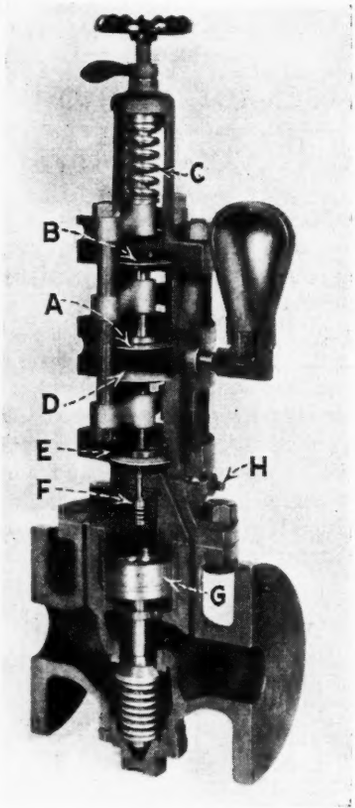
The accompanying illustration shows a three-fuel burner equipped with a 4-in. insulated front for use with preheated air. In addition to liquid waste, it will handle pulverized petroleum, coke and still gas, besides standard fuels such as oil and natural gas.

Excess-Pump-Pressure Regulator

THE excess-pump-pressure regulator (Class X) illustrated, brought out by the Leslie Company, Lyndhurst, N. Y., embodies all the important features of the Leslie class PN pump regulator described in the Jan. 22, 1929, number of *Power* with certain modifications to the operating element to adapt it to excess-pressure service.

Like the pump regulator, sensitiveness is one of the outstanding features of the new valve. This is made possible through the elimination of stuffing boxes on any moving part. In place of the usual central spindle, diaphragms are clamped between flanges in the valve bonnet and the movement is imparted from one diaphragm to the other by external crossheads.

Referring to the illustration, the boiler feed-line pressure is connected below the diaphragm *A* and the boiler pressure above the diaphragm *B*. These two pressures therefore oppose each other, with the boiler pressure assisted by the adjustable spring *C*. Any movement of the diaphragms is transmitted through external crossheads to the diaphragms *D* and *E* and, in turn, to the pilot valve *F*. When the pilot valve opens, steam is admitted above the piston *G*, which is forced downward, opening the main valve and admitting sufficient steam to the pump to maintain the desired excess pressure on the boiler-feed line.



This view shows absence of stuffing boxes and arrangement of external crossheads

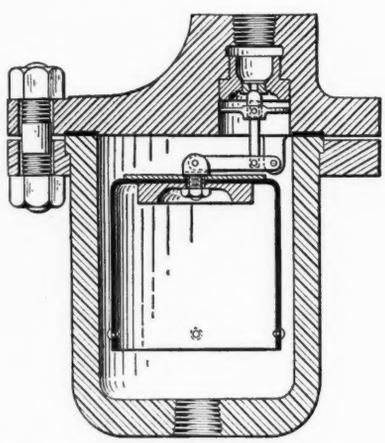
By adjusting the needle valve *H* incorporated in the connection between the diaphragm chambers *D* and *E*, a compensating or stabilizing effect is obtained, which eliminates any tendency of the valve to hunt, a common fault of turbine-driven pumps.

The valve is made of bronze, with renewable wearing parts of stainless steel, nickel alloy and bronze suitable for superheated steam up to total temperatures of 550 deg. F. It is designed for steam pressure up to 300 lb., excess pressure from 10 to 200 lb. up to maximum boiler-feed pressure of 450 lb. Valves with screw ends in sizes from $\frac{1}{2}$ to 2 in., with flanged ends from $\frac{1}{2}$ to $3\frac{1}{2}$ in., inclusive, are available.

Forged-Steel Trap for High Pressures and Temperatures

IN THE MAY 21, 1929, number of *Power* the inverted-bucket steam trap, designated Series 20, put out by the Strong, Carlisle & Hammond Company, Cleveland, Ohio, was illustrated and described. To this line has recently been added the forged steel trap shown in the accompanying illustration.

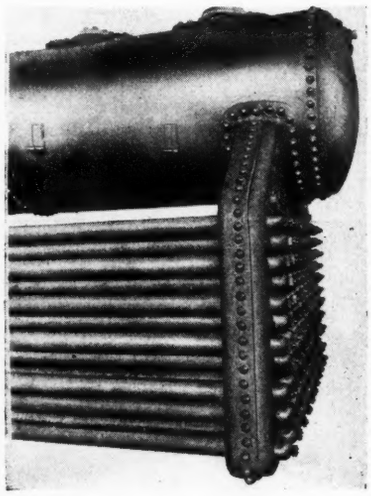
In this trap, which is built in sizes from $\frac{3}{4}$ to 2 in. and for any pressure and temperature, the body is made from a billet, by the same method that is used in making projectiles. A shoulder is formed at the open end of the body and a recessed forged-steel flange is shrunk on against the shoulder, as shown in the illustration. The cover, which carries the valve seat and outlet connection, is also of forged steel, and is secured to the body flange by stud bolts with a nut on each end. All working parts and pins are of "Anum" metal. The principle of operation is identical with the standard-pressure trap previously described.



Section of trap for high-pressure service

Single-Seam Box-Header Boiler

AMONG the advantages claimed for the single-seam box-header boiler construction now used by Combustion Engineering Corporation, 200 Madison Ave., New York, N. Y., on box-header units of the Heine and Walsh-Weidner types are high factor of safety, elimination of the



Single-seam box header

wrapper sheet and one row of rivets, and the placing of the single riveted joint out of the hot gas or fire zone.

As will be apparent from the illustration, the construction gives one calking edge only. This edge faces the outside, making it readily accessible for inspection. Header width between the outside faces of the tube and the handhole sheets is reduced about 3 in.; consequently shorter and stiffer staybolts can be used.

Auxiliary-Operated Pressure Controller

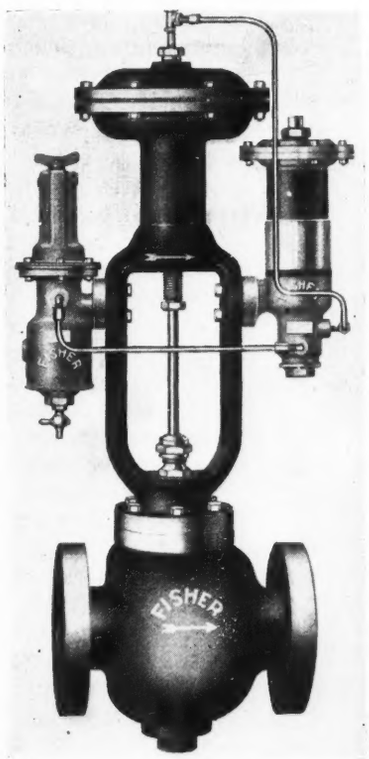
AN AUXILIARY-OPERATED pressure controller designed especially for the condition of service for which a directly actuated regulator is not suited, was recently announced by the Fisher Governor Company, Marshalltown, Iowa.

The services to which this regulator, which is designated the series 2200, is particularly adapted are, according to the manufacturer, where extremely close regulation of pressure is necessary, where the load or flow of steam fluctuates widely, where the reduced pressure is almost as high as the initial pressure, and where severe conditions of corrosion, pressure or temperature have to be met.

An important feature of the regulator is that all moving parts of the main valve and the two control units are entirely inclosed. Therefore it can be used for service in or out of doors without protection from dust, dirt, rain, etc. The main valve and auxiliary control units are incorporated in one compact unit, so that no additional interconnecting piping is required.

Three types of arrangements are available, the one illustrated for use on a horizontal pipe line, with the control units mounted on the bonnet; a similar type for installation on a vertical pipe line in which the control units are placed vertical or at right angles to the main valve bonnet; and one in which the two control units are mounted on a panel board separate from the main valve. Practically any installation requirement can be met with these combinations.

Four distinct classes of service come within the range of the regulator. They are reduced pressure regulation, relief or back pressure service, auxiliary vacuum control, and auxiliary differential pressure control. In addition, it can be used as a make-up valve in connection with a back-pressure turbine where steam is used in process work. Also for reducing the high pressure of a new boiler installation to the low pressure of the existing boiler units and prime movers. It is also applicable for pressure control work in handling such fluids as oils, gas, water, air and certain chemicals in industrial process work.

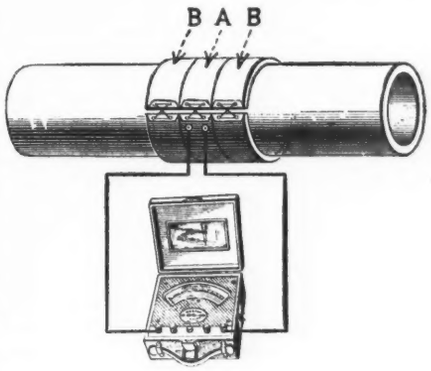


Series 2200 pressure controller

Meter for Direct Measurement of Heat Loss Through Surfaces

WITH A VIEW to providing a simple and convenient means of measuring the heat flow through insulation materials, walls of boiler settings, walls of buildings and flues, and refrigerating apparatus, the Weston Electrical Instrument Corporation, Newark, N. J., has brought out the heat-flow meter illustrated.

This meter indicates directly on a



Heat-flow meter applied to a steam pipe

scale, without computation, the rate of heat flow through a surface in B.t.u. per square foot per hour or other convenient unit. It consists of an indicating millivoltmeter used with a standard heat conductor made in the form of a thin rubber belt, which is placed in the heat circuit so that the heat to be measured must pass through it.

Embedded in the belt, just below the surface, are a number of thermocouple junctions, one set of which is on the outer surface of the belt and the other on the inner. The couples are connected in series and by binding posts on the belt to the indicating instrument.

In the method of measuring the heat loss from a steam pipe shown in the illustration, the central belt *A* is the measuring conductor and the belts *B* on each side of it are for equalizing the flow of heat around it. Where the circumference of the pipe is greater than the length of the belt the three belts are placed side by side,

as shown, but where the circumference is less than the length of the belt the three are laced together, with the measuring belt in the center, wound helically around the pipe and secured in place by cords, using the hooks at the belt ends.

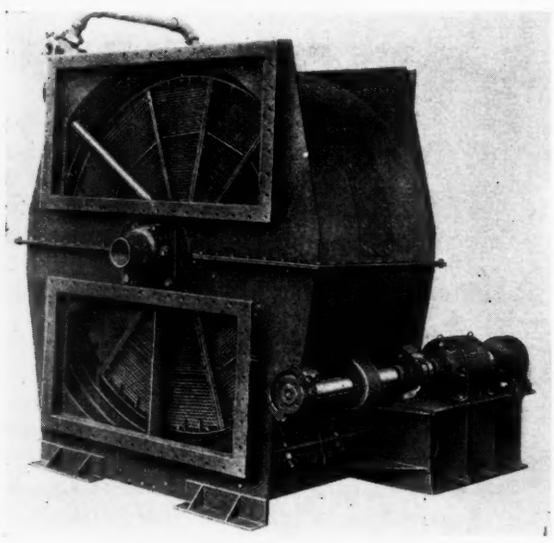
This instrument can be used not only in measuring heat losses in B.t.u. per square foot per hour, but also to measure the conductivity of heat-insulating materials.

Horizontal Rotative-Type Air Preheater

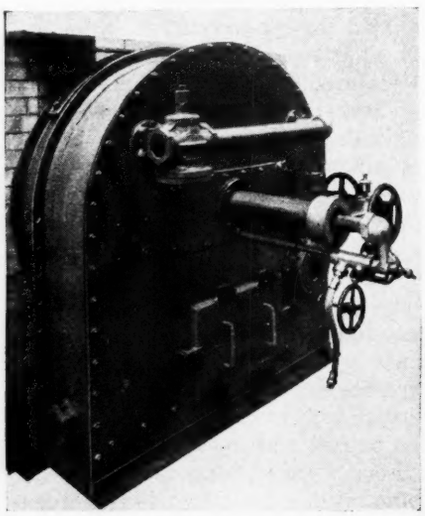
TO THE LINE of Ljungstrom regenerative vertical-type air preheaters put out by the Air Preheater Corporation, New York City, has recently been added the horizontal-type unit illustrated. This unit, designed for use with independent fans, is particularly adaptable to high-temperature industrial work. It also permits of more desirable arrangement of equipment than is usually possible with the vertical type of unit, as well as effecting, in certain cases, a saving in building construction, ducts and fan foundations. It is built in three constructions, for flue-gas temperatures of 1,000, 1,200 and 1,600 deg.

The rotor, on which is mounted the usual Ljungstrom heater elements, is carried on two double-row roller bearings. The shaft is hollow, and water circulation is provided to keep the bearings at a proper operating temperature. The sealing of the rotor is effected in the same way as on the vertical type units, as also is the cleaning, which is assisted by permitting the elements on each section to shift slightly with each rotation of the rotor. In this way the dust and fly-ash accumulations are kept loose and are readily dislodged by the steam jets.

Several sizes of the heater are available. They number from 1 to 22, inclusive, and range in square feet of heating surface from 765 to 58,700.



Type CHNX horizontal air preheater



Front view of burner

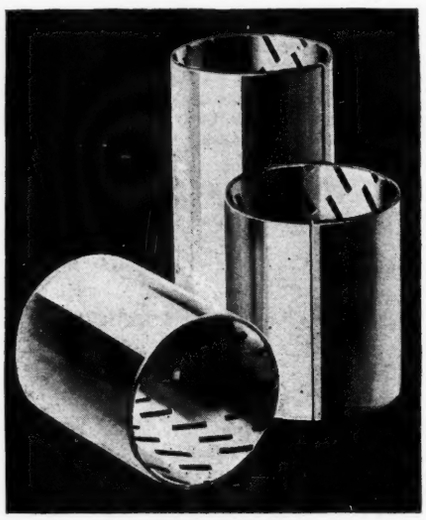
Large-Capacity Burner for Oil and Gas

TO OBVIATE the usual multiplicity of oil or gas burners on large boiler units, the high-capacity type "D" burner illustrated has been developed by the Engineer Company, 17 Battery Place, New York, N. Y.

This combination burner, which is built in units capable of supplying boilers ranging from 15,000 to 25,000 sq.ft. of heating surface, is of unusually heavy construction and is arranged for forced-draft operation. The oil burner itself is made either in the steam-atomizing type, throwing a hollow cone spray, or in the regular mechanical or pressure-type. Hand wheels are provided to effect the various adjustments of the air-inlet shutter and burner position with respect to furnace opening. When the burner is used with other fuels, such as bagasse or hogged fuel, it can be completely shut off from the furnace with a refractory closing member, thus obviating the use of high-temperature metal.

New Self-Lubricating Bearing

A NEW self-lubricating bronze bearing designed to provide for a uniform area of bearing surface on the pressure line and insure an efficient distribution of lubricating compound, is announced by the Johnson Bronze Company, New Castle, Pa. The improved results are obtained by a new method of effecting indentations in the metal and by placing them on an angle of 30 deg. These indentations serve as an effective receptacle for the lubricating compound. The new bearing is particularly suitable for use on parts of equipment subject to intermittent or periodical operation.



Self lubricating bronze bushings

High-Temperature Cement

IN THIS NEW PRODUCT, designated Adachrome Plastic Super-Cement, introduced by Bot-field Refractories Company, Philadelphia, Pa., the basic material is chromite ore obtained from South African deposits.

Among the destructive furnace actions to which this new cement is said to be resistant are basic and acid slags, molten metal penetration, abrasion, erosion and chemical reaction in the burning of acid sludge. In addition, the material when applied as a surface coating on boiler settings protects the brickwork from the penetrating action of clinker and fusible coal ash.

It is suited for making either dipped or troweled joints. Two sizes of drums, 250 lb. and 500 lb., are available.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

*Spot * News*

AUTHORITY *for the construction of a dam and power plant at Kettle Falls on the Columbia River, Wash., eventually capable of generating 240,000 hp. and estimated to cost $19,250,000, has been granted to the Washington Electric Company of Seattle, it was announced Jan. 21 by the Federal Power Commission.*

* * *

ONE BY ONE *the legal conundrums presented by the Boulder Dam act have been interpreted by Edward C. Finney, solicitor of the Department of the Interior. All told, there have been fourteen opinions rendered on various aspects of the law, which are now available in mimeographed form to all persons requesting a copy.*

* * *

EXTENSIONS *to the City of Seattle's light and power system, to cost approximately $10,000,000, are provided for in a bill now being considered by the city council. They include the purchase of a new steam generating plant and additions to the Lake Union steam station.*

* * *

NET OUTPUT *of generating stations of the New York Edison Company and associated companies during 1929 was 4,679,000,000 kw.-hr., as compared with 4,211,000,000 kw.-hr. in 1928, an increase of 11.1 per cent, it has just been announced by the company.*

* * *

MILLIONS OF DOLLARS *will be invested and work started on projects in 1930 that will add more than 400,000 hp. to the installed capacity of plants in North Carolina, according to figures on the power industry just released by the division of water resources and engineering of the State Department of Conservation and Development.*

* * *

"SAN FRANCISCO STEAM PLANT" *has been announced by the Great Western Power Company of California as the official designation of its new steam plant in India Basin on the shore of San Francisco Bay.*

Delegates From 49 Nations to Take Part in Second World Power Conference at Berlin, Next June

THE United States will be one of the leading participants in the World Power Conference to be held in Berlin, next June 16 to 25, calling together engineers, economists, chiefs of industry, agricultural experts and specialists in education from forty-nine countries. The conference will be held for the interchange of world views on the use and development of power and discussion of methods by which the power resources of the world may be utilized more completely.

Leaders in science, finance and manufacture abroad, as well as rulers and heads of governments are ranging themselves in cooperation with a large German sponsoring committee now making arrangements for the international meeting. Officially known as the Second Plenary World Power Conference, the meeting will bring together the largest group of power savants ever assembled in the history of the world. The gathering has the personal patronage of President von Hindenburg of Germany, who will act as official sponsor for the meeting. The honorary president of the conference is His Excellency Geheimer Baurat Dr. Ing. E. h. C. von Miller, and the chairman is Generaldirektor Dr. E. h. C. Köttgen.

Lamont Heads U. S. Group

Co-operating with the German group is an American committee, of which Robert P. Lamont, Secretary of Commerce, is honorary chairman and which has its headquarters in the Edmonds Building, Washington. Honorary vice-chairmen of this group are Patrick J. Hurley, Secretary of War; Ray Lyman Wilbur, Secretary of the Interior; A M. Hyde, Secretary of Agriculture; William H. Bassett, first vice-president of the American Institute of Mining & Metallurgical Engineers; Owen D. Young, chairman of the General Electric Company; A. W. Robertson, chairman of the Westinghouse Electric & Manufacturing Company; Matthew S. Sloan, president of the National Electric Light Association; James H. McGraw, chairman of the McGraw-Hill Publishing Company; Sidney Z. Mitchell, chairman of the Electric Bond & Share Company; Samuel Insull, president of the Commonwealth Edison Company of Chicago; George B. Cortelyou, president of the Consolidated Gas Company, New York; Charles Piez, president of the American Society of Mechanical Engineers; and John F. Coleman, president of the American Society of Civil Engineers. The chairman of the American committee is O. C. Merrill of Washington, formerly executive secretary of the Federal Power Commission. Henry J. Pierce of the Electric Bond & Share Company, New York, is vice-chairman, and H. M. Addinsell of Harris, Forbes & Company, New York, is treasurer.

Four Classes of Papers

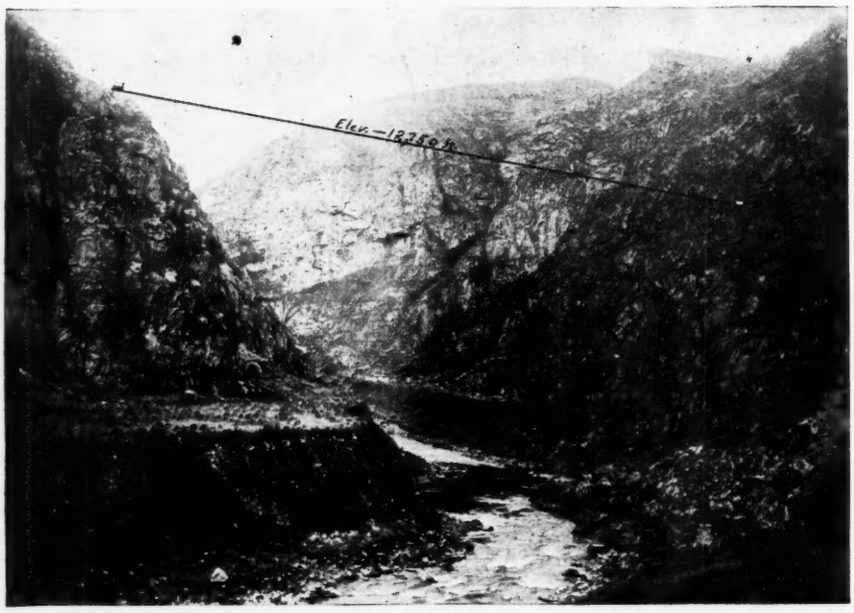
Discussion of the subject coming up at the conference will be divided into four classes. Sources of power will be in class A; power production, power transmission and storage will come under class B; utilization of power will be in class C, and general subjects will come under class D. A large corps of American scientists and engineers will prepare papers and take part in these discussion sessions.

Arrangements by which the delegates to the conference may witness the latest developments in industry in Germany are being made by the German sponsoring group. Works manufacturing electrical machinery, turbines and gas plant apparatus; power plants utilizing lignite and powdered fuel; technical colleges and trade schools; commercial works and soft-coal mines; iron and steel mills, hydro-electric, steam and electro-chemical plants; metallurgical works, shipyards and other industrial establishments will be visited.

The program of the conference will get under way with a reception for the participants in the Reichstag Building on Sunday, June 15. The opening ceremony of the conference proper will take place on Monday, June 16, at the State Opera House in Berlin, where all the general sessions will be held.

Transportation arrangements for Americans attending the World Power Conference include chartering of the Hamburg American liner "Resolute," the entire first cabin of which has been set aside for the use of American delegates and their families. The "Resolute" will leave New York June 4 and will land nine days later in Cuxhaven, whence a special train will convey the American delegates to Berlin.

Erecting 35,000-Hp. Plant in Peru



Line indicates where 200-ft. dam will be located in Montaro River power development of the Cerro de Pasco Copper Corporation

UNDER the direction of Sanderson & Porter, consulting engineers, work on the new hydro-electric plant to be located about sixteen miles north of Oroya, Peru, at Malpaso on the Montaro River has been well started. This plant, which will furnish 35,000 hp. and will cost about $6,500,000, will furnish power for the Cerro de Pasco Copper Corporation, largest non-ferrous metal producer in Peru, operating mines and smelters within 75 miles of the plant.

Power developed by the corporation in 1929 at its two hydro-electric plants on the Yauli River and at its Oroya steam plant averaged about 23,660 hp., as compared with 21,150 hp. for 1928. Power shortage during the Peruvian dry season has frequently hampered production from the mines. Most of the new power will probably be used in an electrolytic zinc plant that will be built at Oroya. The plant should be operating early in 1931.

Finance Follows Publicity in Utility Inquiry

The Federal Trade Commission has tentatively set Feb. 4 as the date for beginning hearings on financial phases of its investigation of power and gas utilities, according to a recent announcement of the commission.

This part of the investigation will be presented in relation to separate companies or affiliated groups of operating, holding, service or management companies. Data for use in the hearings on financial activities have been in process of collection ever since the investigation began. Agents of the commission have worked in the offices of large companies in many parts of the country developing facts relating to the growth of capital assets and liabilities and other features called for in the Senate resolution.

Hearings on the main publicity phases of the inquiry came to a close Jan. 18 when 96 documents offered by Bernard F. Weadock, special counsel for the utilities, as evidence of an organized campaign to disrupt and socialize the utilities, were excluded from the record by a ruling of Commissioner Edgar A. McCulloch, who presided.

Western States Plan New Hydro Plants

Application on behalf of the City of Tacoma, Wash., has been filed with the State Hydraulics office in Olympia, contemplating a hydro-electric municipal power development on the upper reaches of the Cowlitz River. This is designed to supplement the city's Lake Cushman and Nisqually River plants now in operation. The plant includes the diversion of 125 sec.-ft. of water from Clear Fork stream into Packwood Lake in Lewis County by means of a tunnel 10x12 ft. in diameter and 5.4 miles long, and the impounding of 65,000 acre-ft. of water in the Lake by means of a dam 105 ft. high and 600 ft. long, of rock-fill and concrete-core construction. The cost is put at $1,500,000 for the tunneling and $755,700 for the reservoir.

The application further seeks the appropriation of 250 sec.-ft. of water from Lake Creek to be conveyed to the power plant by means of 16,000 ft. of tunnel and 6,000 ft. of pipe line, this work and the generating plant to cost approximately $6,120,000.

In the Packwood Lake power project, the city will have a project with a potential 40,000 to 50,000 continuous horsepower, with storage sufficient for a complete regulation of the stream, and with the largest head of any power project in the section thus far studied, more than 1,700 ft., according to the statement made by Commissioner Ira A. Davisson in explaining the filings. The Packwood Lake project will justify probably 60,000 to 90,000 hp. generator capacity, according to the load it will be expected to carry in conjunction with the other units on the city's system.

Montana Plant

Within a month's time the Montana Power Company, with headquarters in Butte, expects to have completed its Morony hydro-electric project on the Missouri River, 15 miles below Great Falls, Mont., and 5 miles below its Volta power house. The Morony power plant is the eighth that has been erected by the Montana company on the Missouri River.

The Morony project, named in honor of the late John G. Morony, one of the founders of the Montana Power Company, consists of a 90-ft. concrete dam of the gravity type, which forms a storage reservoir of 2,000 acre-ft. capacity, and a 45,000-kw. power house. The power house equipment consists of two 31,000-hp. I. P. Morris vertical reaction turbines, operated under an 82-ft. head, and two 25,000 kva. Westinghouse generators.

Water-Tube Boilers Show Largest Gain in 1929

Water-tube boilers showed the greatest gain in sales during 1929 of any type of boiler, with a total for the year of 1,643 of 9,396,526 sq.ft. as compared with 1,315 of 6,909,982 sq.ft. for 1928. Horizontal-return-tubular boiler sales were less in number, but the square feet of heating surface was about the same, indicating that larger units were sold in 1929.

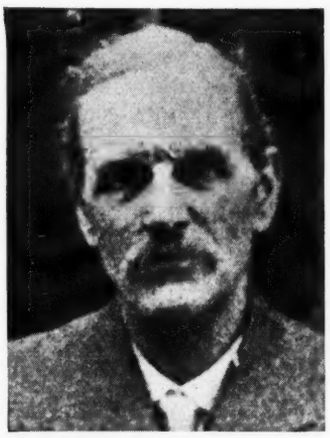
Total orders for 1929 amounted to 18,518 boilers having 19,453,258 sq.ft., as compared with 19,672 boilers having 17,684,811 sq.ft. during 1928. The following table presents the total number and square footage of each type of boiler ordered in 1928 and 1929:

	Total, 1928		Total, 1929	
	No.	Sq.Ft.	No.	Sq.Ft.
Stationary				
Water tube	1,315	6,909,982	1,643	9,396,526
Horizontal return tubular	1,513	1,884,401	1,365	1,827,752
Vertical fire tube	1,726	495,674	1,649	485,574
Locomotive (not railway)	392	263,201	284	226,043
Steel heating	12,685	6,152,393	11,438	5,233,481
Oil country	956	900,317	1,142	1,168,817
Self contained portable	680	462,627	589	406,559
Miscellaneous	174	76,285	168	99,250
Total	19,441	17,144,880	18,278	18,844,002
Marine				
Water tube	99	467,084	127	506,167
Pipe	3	3,623	10	11,119
Scotch	112	59,649	91	77,577
2 and 3 flue	13	5,577	3	2,180
Miscellaneous	4	3,998	9	12,213
Total	231	539,931	240	609,256
Grand total	19,672	17,684,811	18,518	19,453,258

Prof. Callendar, British Steam Expert, Dies

Hugh Longbourne Callendar, noted British steam-table expert and professor of physics at the Imperial College of Science and Technology, London, England, died suddenly the morning of Jan. 22. He was 67 years of age.

Born at Hatherop, Professor Callendar was educated at Trinity College of Cambridge University. He went to Montreal, Canada, in 1893, where he became professor of physics at McGill University. In 1898 he returned to



H. L. Callendar

London as professor of physics at University College, remaining there until 1920, when he was made professor of physics at the Imperial College of Science and Technology. He was elected a Fellow of the Royal Society in 1894 and a Fellow of the Royal Society of Canada in 1896.

Early in his career Professor Callendar became interested in research on the physical properties of steam. He conducted many experiments and formu'ated a set of steam tables that were widely accepted by British engineers and finally adopted as standard by the British Electrical and Allied Manufacturers' Association. At the steam-table conference in London last July, he played a prominent part in the establishment of basic international values for steam properties.

Thomas Shipley Dies

Thomas Shipley, president and general manager of the York Ice Machinery Corporation, died at his home in York, Pa., early Wednesday morning, Jan. 22, after an illness of several months' duration. He was born in Jersey City, N. J., June 30, 1861.

Graduating from Cooper Union, New York City, in 1881, Mr. Shipley found his first employment with the Morris & Cummings Dredging Company of Jersey City, where he served as apprentice, machinist and draftsman. His next venture was in making ice machinery, and in 1886 he became connected with the Frick Company, of Waynesboro, Pa., as a mechanical engineer and refrigeration expert.

In 1897 he went to York to take the position of general manager of the York Manufacturing Company. Several years ago, a dream long cherished by Mr. Shipley became a reality when leading firms interested in the manufacture of ice machinery in different parts of the United States were merged with the York company, and the York Ice Machinery Corporation was formed. He became president and general manager of the consolidation.

Business Forecast

IF THE business thermometer is not rising perceptibly enough to warm business sentiment very much, it has at least stopped dropping. Each week brings further evidence that the decline has been checked and that a definite upturn is not far off. Basic industrial activity has quickened, though primary distribution and general trade are seasonally slack and still somewhat hesitant. Steel operations have shown an unusually strong year start; general building is moving at a higher level than in December; and if government reports are true, an upturn in employment in January has resulted from organized business support of the President's efforts.

—From the outlook the *Business Week* will print in its issue of Jan. 29.

Power Machinery Demand Growing in Mexico

American industrial machinery holds a dominant position in Mexico, according to Commercial Attaché George Wythe in a study of that market just issued by the Department of Commerce. Last year total imports from the United States of this class of goods reached a value of approximately $10,000,000 as compared with about half that figure in 1913. American manufacturers are now making practically all of the new installations for sugar mills and are securing a substantial part of the business in textile machinery, two lines in which the British formerly dominated.

In prewar times, the report shows, Great Britain was the strongest competitor of the United States in Mexico for the industrial machinery business, with Germany third. At the present time this situation is reversed. The British are still strong in water-tube boilers, steam turbines and textile machinery. German competition is principally in the lines of Diesel and semi-Diesel engines, pumps, metal and wood-working machinery, and certain mining equipment, such as dump cars and aerial tram lines. Germany, however, no longer has a monopoly on Diesel engines.

News of Canada

Four Western Provinces Pushing Power Development in Program of Industrial Expansion

IN the four Western Canadian provinces hydro-electric development is ranking as the overwhelming factor in the industrial expansion of 1930. Manitoba has 300,000 hp. hydro-electric output and a total of 750,000 in view, with the works underway. At present, available sites with a possible development of 3,000,000 hp., on the Nelson, the Churchill and other adjacent streams of the Hudson Bay watershed, are being negotiated for by British-Canadian-American interests. The fact that the province now controls these public resources is contributing to the definite negotiations for utilizing the power.

In Saskatchewan, which has not yet obtained control of its natural resources, plans are underway for surveys which, it is expected, will result in the development of at least a million horsepower in the northern section of the province. The larger portion of the Flin Flon copper area extends westward into Saskatchewan. This is giving an impetus to development of northern hydro sites in that province. In the southern section the government is developing electrical energy from coal of which there are great quantities.

350,000-HP. PROJECT PLANNED

The province of Alberta has control of her natural resources now and negotiations are under way for ultimate development of 2,000,000 hp. from the Rock Mountain streams. The Calgary Power Company, the pioneer in the hydro field of that province, has its colossal works well under way to control central Alberta water power, but the northern sites are being negotiated for by at least two large organizations representing British and Canadian capital.

British Columbia is feeling the impetus of large aggregations of capital to control the hydro fields of that province. British Columbia Electric has underway several large developments near Vancouver. Further along the coast two other companies are competing for sites that have potential development estimated at 1,000,000 hp. The latest announcement of work to be undertaken in the near future is by the West Kootenay Light & Power Company, which has plans for the development of 350,000 hp. on the Pend d'Oreille River at a cost of approximately $18,000,000.

There is a very definite tendency on the part of the four western provinces to encourage hydro development by private capital, but with reasonable control through provincial commissions that will not only assure industry against being exploited, but will enable each government to conduct a public utility of its own, ultimately, if desired.

Late William J. A. London Was Noted Turbine Designer

Though William James Albert London, prominent steam-turbine designer and works manager of the Reider-Ericsson Company, has been dead for some weeks, there is much of interest for engineers in the power field to be found in the full account of his life just received by *Power*. He died of apoplexy on Nov. 14, 1929, at his home in Walden, N. Y.

Born at South Hylton, England, on Mar. 3, 1877, Mr. London received his

W. J. A. London

early education at Dame Allan's School, Newcastle-on-Tyne. In 1893, he was apprenticed to C. A. Parsons & Company, Heaton Works, Newcastle-on-Tyne, England, where he attended a full course of classes at Armstrong College. Upon completion of his apprenticeship, he became a draftsman. During this period he was associated with the early stages of reaction-turbine development. In 1900 he joined Brown, Boveri & Company, of Baden, Switzerland, who at that time acquired a license under the Parsons' steam-turbine patents. In 1902 he entered the employ of the British Westinghouse Company, at Trafford Park, near Manchester, becoming responsible for steam-turbine developments then being undertaken there.

George Westinghouse, impressed with London's versatility as a designer, had him transferred, in 1906, to the East Pittsburgh works of the Westinghouse Machine Company, where London carried out some special experimental work, principally in connection with marine propulsion. This concluded, in 1908 he accepted a position as chief engineer of the Terry Steam Turbine Company, of Hartford, Conn. The Terry company was at that time building small single-wheel turbines of the general type developed by Riedler-Stumpf in Germany. By London's persistent endeavor, the efficiency of the Terry turbine was established and methods of calculation evolved that permitted the prediction of efficiencies that could be demonstrated by test. He further developed a series of multi-stage turbines adaptable to condensing service, ever striving for rational standardization and simplicity.

In 1927 he became associated with the Peabody Engineering Company and undertook some important development in coal pulverization at the works of the Reider-Ericsson Company in Walden, N. Y. At the successful conclusion of these tests, in January, 1929, he became works manager.

Coming Conventions

American Society of Mechanical Engineers. Fiftieth Anniversary Celebration at New York City, Hoboken, N. J., and Washington, D. C., April 5-9, 1930. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

American Welding Society. Annual meeting at society headquarters in New York City, April 22-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

Engineering Institute of Canada. Annual meeting at the Chateau Laurier, Ottawa, Ont., Feb. 12-14, 1930. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

International Heating & Ventilating Exposition. Commercial Museum, Philadelphia, Pa., Jan. 27-31, 1930. Manager, C. F. Roth, Grand Central Palace, New York City.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

International Railway Fuel Association. Annual meeting at the Hotel Sherman, Chicago, Ill., May 6-9. Secretary, C. T. Winkless, Room 700, LaSalle St., Station, Chicago, Ill:

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Marine Engineers' Beneficial Association. Annual convention at Hotel Barlum, Detroit, Mich., the week of Feb. 10, 1930. Secretary, A. L. Jones, 9th St. and Mount Vernon Place, N. W., Washington, D. C.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

PERSONALS

A. A. POTTER, dean of engineering at Purdue University, has been appointed a member of the A.S.M.E. Research Committee for a five-year term. He takes the place made vacant by the retirement of Prof. A. E. White, director of the Department of Engineering Research of the University of Michigan, whose five-year term on the committee expired last December.

MARGARET INGELS, the first woman to receive a degree in mechanical engineering from the University of Kentucky, and former research engineer for the American Society of Heating and Ventilating Engineers and the State of New York, has joined the Carrier-Lyle Corporation, as an engineer specializing in the development and use of air-conditioning devices.

H. KRIEGSHEIM, who has been president of the Permutit Company for the past seven years, has been appointed chairman of the board. He will continue to take an active interest in the management of the company.

H. HOBART PORTER, chairman of the Engineering Foundation and president of the American Water Works & Electric Company, sailed on the SS. Columbus Jan. 21 for a cruise around the world. Mr. Porter is a trustee of Columbia University.

JOSEPH V. SANTRY has been appointed president of Combustion Engineering Corporation to succeed Col. H. D. Savage, who is assisting Wilfred R. Wood and the Irving Trust Company, receivers of the organization. Mr. Santry, who became identified with the corporation shortly after its establishment in 1914, served successively as director, vice-president and president, resigning about two years ago.

GEORGE A. RUST has been elected vice-president in charge of purchasing for Charles H. Tenney & Company, with headquarters at Boston, Mass. Mr. Rust has been with the Tenney organization since 1905.

CHARLES E. WILSON, formerly assistant to the vice-president, has been named manager of the merchandise department of the General Electric Company, Bridgeport, Conn. He will continue to have supervision of the engineering and manufacturing activities of the department.

WILLIAM S. SCHMIDT, electrical engineer with the Pennsylvania-Ohio Power & Light Company, has been appointed assistant general superintendent of the electrical department of the Penn-Ohio company and the Pennsylvania Power Company.

Business Notes

Allis-Chalmers Manufacturing Company, Milwaukee, Wis., announces the establishment of a Chattanooga sales office at 633-4 Tennessee Electric Power Building, Chattanooga, Tenn. This office, with D. S. Kerr in charge and A. I. Richardson as sales engineer, will operate as a branch of the Atlanta district office, which is under the direction of Berrien Moore.

Buffalo Forge Company, Buffalo, N. Y., announces the election at the annual meeting of its directors of the following officers: H. W. Wendt, Jr., chairman; Edgar F. Wendt, president and treasurer; Charles A. Booth, vice-president; and Herbert S. Whiting, secretary.

Arthur J. Herschmann, mechanical engineer, of 50 Church St., New York City, is now U. S. representative of Witkowitz, the leading steel works of Czechoslovakia.

Reliance Electric & Engineering Company, Cleveland, Ohio, has moved its Pittsburgh, Pa., office to new and enlarged quarters at 2300 Koppers Building.

Buffalo Steam Pump Company, Buffalo, N. Y., announces the election at the annual meeting of its directors of the following officers: Edgar F. Wendt, president and treasurer; Henry W. Wendt, Jr., vice-president; and Amos G. Peterson, secretary.

King Refractories Company, Buffalo, N. Y., has moved its New York district sales office from 110 West 34th St. to Suite 906, 5 Beekman St., with E. H. Striegel, district manager, in charge. John P. Windolf, Jr., formerly with the New York Edison Company, is now associated with Mr. Striegel in the promotion of sales in this territory.

C. A. Dunham Company, Chicago, Ill., has purchased the Dwyer Equipment Company of Chicago. Lawrence P. Dwyer, president, and William J. Mauer, vice-president of the latter company, join the Dunham organization as general manager and sales manager, respectively, of the unit heater division. The Dwyer plant, now located in Chicago, will be moved to the newly constructed Michigan City factory of the Dunham company.

General Electric Company, Schenectady, N. Y., announces that holders of approximately 75 per cent of its common stock voted at a special meeting on Jan. 15 in favor of a four-for-one split-up of the present no-par-value common stock. When the change becomes effective, the total authorized common stock of the company will be 29,600,000 shares without par value.

With the Society Sections

A.S.M.E., Metropolitan Section. Meeting in Room 502, Engineering Societies Building, Feb. 3, at 8 p.m. Subject: "Development of a High-Pressure System of Boiler-Water Conditioning."

A.SM.E., Philadelphia Section. Meeting at the Bellevue-Stratford Hotel, Jan. 28, at 8 p.m. Subject: "The Pioneer High-Pressure Industrial Plant of America," by W. E. S. Dyer, consulting engineer, Philadelphia. At this meeting descriptive data on the Philip Carey 1,840-lb. pressure plant, using reciprocating engines, will be presented.

A.S.M.E., Providence Section. Meeting in the Providence Engineering Society rooms, Jan. 31, at 8 p.m. Subject: "Bearings and Lubrication," by Dr. A. E. Norton, professor of mechanical engineering at Harvard University, Cambridge, Mass.

American Standards Association. Conference of manufacturers, distributors and users of leather belting to determine whether national standards shall be established, in Room 1105, Engineering Societies Building, 29 West 39th St., New York City, on Feb. 6 at 10:30 a.m.

Engineering Societies of Boston. Annual dinner and gala entertainment will be given at the Copley Plaza Hotel on Feb. 12.

Trade Catalogs

Conveyors—A complete handbook on materials-handling equipment (Catalog No. 75) has recently been published by the Robins Conveying Belt Company, 15 Park Row, New York City. Divided into fourteen sections, this 300-page book contains estimating, engineering and designing data on many new and proven types of conveyors with their applications. Among those described and illustrated are belt conveyors, bucket elevators, dragline scrapers, feeders and skip hoists. Of particular interest is the section devoted to boiler house coaling.

Draft Control—Bulletin No. 100 of the Shallcross Control Systems Company, 1195 30th St., Milwaukee, Wis., contains a comprehensive description of the Shallcross automatic draft-control system for boiler furnaces. Illustrations in color heighten the interest in this 12-page booklet.

Smoke Abatement—"Grit Emission and the Remedy" is the title of a new publication of Pneumatic Conveyance & Extraction (1929) Ltd., Broadway Buildings, Broadway, Westminster, London, S.W.1. A treatise on atmospheric pollution prepared by W. A. Smith, this 56-page book contains many photographs and sectional drawings of grit-catching equipment.

Pumps—A new pump bulletin, No. 200, entitled "Goulds Centrifugal Pump Selection Charts," has just been issued by Goulds Pumps, Inc., of Seneca Falls, N. Y. Contained in this 40-page illustrated booklet are eight charts showing the efficient range of 26 different pumps at five different speeds, as well as a complete description of Goulds horizontally-split, enclosed-impeller, single-stage, double-suction pumps.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.25 @$2.50
Kanawha.....	Columbus.....	1.30 @ 1.60
Smokeless.....	Cincinnati.....	2.00 @ 2.25
Smokeless.....	Chicago.....	2.00 @ 2.25
S. E. Kentucky...	Chicago.....	1.30 @ 1.60
Steam.....	Pittsburgh.....	1.50 @ 1.75
Gas Slack.....	Pittsburgh.....	1.00 @ 1.20
Big Seam.....	Birmingham....	1.25 @ 1.50
Anthracite		
(Gross Tons)		
Buckwheat.....	New York.....	$2.75@$3.00
Barley.....	New York.....	1.40@ 1.50

FUEL OIL

New York—Jan. 23, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Jan. 15, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.695 per bbl., or 42 gal.; 26@28 deg., $1.745 per bbl.; 28@30 deg., $1.795 per bbl.; 30@32 deg., $1.845 per bbl.; 32@36 deg., gas oil, 4.901c. per gal.; 37@40 deg., distillate, 5.73c. per gal.

Pittsburgh—Jan. 14, f.o.b. local refinery, 30@34 deg., fuel oil, 4.5@4.75c. per gal.; 36@40 deg., 4.62½@4.75c.

Philadelphia—Jan. 17, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Jan. 21, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Jan. 14, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., $1.02½@$1.07½ per bbl.; 30@32 deg., $1.30@$1.35 per bbl.

Boston—Jan. 18, tank-car lots, f.o.b., 12@14 deg., Baume, $1.05 per bbl.; 30@32 deg., 5c. per gal.

Dallas—Jan. 18, f.o.b. local refinery 26@30 deg., $1.35 per bbl. or 42 gallons.

New Plant Construction

PREPARED TO FURNISH A MORE COMPLETEINESS NEWS DEPARTMENT, WHICH IS COMPILED BY THE MCGRAW-HILL BUS DAILY SERVICE TO THOSE WHO WISH IT

Ala., Birmingham—Birmingham Water Works Co., H. H. Horner, V. Pres. and Gen. Supt., 2114 First Ave. N., appropriated $500,000 for expansion for 1930. Of this amount $150,000 will be expended replacing the dam on the Cahaba River and a new standby pump at Rosedale Station.

Ariz., Christmas — Christmas Copper Co., plans addition to power plant consisting of one Chicago Pneumatic Benz Diesel engine, 450 hp. driving a 300 kva. G. E., 60 cycle 2,200 v. generator; addition of three new panels to switchboard and a new voltage regulator; also plans to erect a five section steel gallows frame over their new shaft and install a 250 hp. Allis-Chalmers double drum hoist, two Sullivan angle compound air compressors, each compressor to be driven by a 125 hp. synchronous motor. Total expenditure $60,000 for surface machinery and improvements.

Ark., Harrison — Arkansas Power & Light Corp., Pine Bluff, is having preliminary studies made for the construction of a hydro-electric power plant on White River near here. Estimated cost $1,000,000. C. S. Lynch, c/o owner, is engineer.

Calif., Glendale—City received lowest bid for the construction of a substation from Baruch Corp., Lincoln Bldg., Los Angeles. $47,437.

Calif., Los Angeles—Municipal Improvement Dist. No. 75, plans an election to vote $510,000 for waterworks improvements, including pumping plant, pipe lines, etc.

Calif., Palo Alto—City is having plans prepared for waterworks improvements, including well and pumping plant at Colorado Ave. and Alma St. Estimated cost $13,500. J. F. Byxbee, Jr., is city engineer.

Calif., Turlock—City is having plans prepared for the construction of fifth auxiliary pumping plant in connection with water system. H. Hall is city engineer.

Conn., Hartford — U. S. Veterans Bureau Washington, D. C., will receive bids until Jan. 30 for the construction of a group of buildings, including boiler plant, refrigerating and ice making plant, etc., at U. S. Veterans Hospital, here.

D. C., Washington—Potomac Electric Power Co., awarded contract for the construction of a sub-station to Skinker-Garrett Co., $41,759.

Ga., Savannah—City is having plans prepared for the construction of a hydro-electric plant. Estimated cost $6,000,000. Burns & McDonnell Engineering Co., 401 Interstate Bldg., Kansas City, Mo., are engineers.

Ind., Knightown—Indian Soldiers & Sailors Orphans Home, awarded contract for the construction of a power house and laundry to Steinkamp Construction Co., Batesville. Estimated cost $150,000.

Ia., Muscatine—Bd. of Light Trustees, J. E. Tuttle, Supt. Municipal Light Plant, awarded contract for a 1,000 hp. water tube boiler to Murray Boiler Works, Burlington, $30,246, stoker to Westinghouse Electric & Mfg. Co., Equitable Bldg., Des Moines, $14,300, 100 ton coal bunker to Doniphan Construction Co., St. Paul, Minn.

Kentucky — Kentucky Utilities Co., Starks Bldg., Louisville, plans general improvements consisting mostly of transmission lines, transformers and tieing into Kentucky Power Co. Estimated cost $2,000,000. Work will be done by owner's Construction Department.

Mass., Mattapan (Boston P. O.)—Hospital Dept., J. J. Dowling, Supt., 8115 Harrison Ave., Boston, will receive bids until Feb. 4 for additions and alterations to boiler plant at Tuberculosis Hospital, River St., here. Estimated cost $190,000. J. Ritchie & Associates, 100 Arlington St., Boston, are engineers.

Mass., Roxbury (Boston P. O.) — Edison Electric Illuminating Co., C. L. Edgar, Pres., 39 Boylston St., Boston, will soon award contract for the construction of electric sub-station No. 52 on Hampshire St., here. Bigelow, Wadsworth, Hubbard & Smith, 11 Beacon St., Boston, are engineers. Also addition to sub-station No. 17 on State St., Newton, $40,000.

Mich., Detroit—Public Lighting Commission, J. S. Foley, Secy., will receive bids until Jan. 30 for the construction of an outdoor sub-station and installation of electrical equipment at Greenfield sub-station as part of power transmission system. Estimated cost $50,000. Smith, Hinchman & Grylls, 800 Marquette Bldg., are engineers.

Mo., Campbell—City defeated $60,000 bonds for power house and distribution system. Russell & Avon, 408 McDaniels, 6200 Easton Ave., St Louis, Engrs.

N. J., Hackensack — Bd. of Chosen Freeholders, Court House, plans the construction of a 2 story central heating plant in connection with court house on Hudson St. Estimated cost $200,000.

N. J., Trenton—State Bd. of Education, State House, is having sketches made for the construction of a power plant at Trenton Normal School, Hillwood St .and Pennington Rd. Estimated cost $40,000. Guilbert & Betelle, 20 Branford Pl., Newark, are architects.

N. Y., Riverhead—Dept. of Mental Hygiene, Albany, will receive bids until Feb. 19 for the construction of a power house and service tunnels at Pilgrim State Hospital, Suffolk County, here.

N. Y., White Plains — Westchester County Lighting Co., E. H. Rosenquest, Pres., 9 South First Ave., Mt. Vernon, plans an $8,000,000 expansion program for 1930. Plans include electric power distribution system additions, substations, etc., in various locations.

N. Y., Willard—Dept. of Mental Hygiene, Albany, received lowest bid for additions and alterations to power plant, including new boiler and stoker, etc., at Willard State Hospital here, from Havens Construction Co., 115 West State St., Olean.

O., Cincinnati — Hamilton County Tuberculosis Hospital, Court House, awarded contract for the construction of a power plant and laundry on Guerley Rd., to C. F. Meinken, 2143 Bernard St. Estimated cost $218,000.

O., Waterville — City Council, passed an ordinance authorizing local board of public affairs to construct light and power plant to supply needs of village and power for local industries.

Pa., Philadelphia—Lit Bros., 8th and Market Sts., will soon award contract for the construction of a 2 story, 80 x 127 ft. power plant at Filbert and 7th Sts. Estimated cost $250,000. Simon & Simon, Fidelity-Philadelphia Trust Bldg., are architects.

Tex., Amarillo — American Commonwealth Corp., and Southwestern Pacific Service Corp., c/o Texas Utilities Co., Amarillo, joint owners, awarded contract for the construction of a super power plant here, to C. S. Lambie Construction Co., Amarillo. Estimated cost $80,000.

Tex., Edna—City Commissioners, will soon award contract for waterworks system including pumping unit, etc. Estimated cost $45,000. M. Fooshee, Paris, is engineer.

Tex., Harlingen—Central Power & Light Co., Frost Bldg., San Antonio, awraded contract for the construction of a 69 x 90 ft. cold storage plant here, to W. A. Velten, Brownsville. Estimated cost $69,199.

Wis., Racine—St. Mary's Hospital, will receive bids after Apr. 1 for the construction of a 5 story hospital, including nurses home, power plant, etc. Estimated cost $1,500,000. V. J. Klutho, 915 Syndicate Trust Bldg., St. Louis, Mo., is architect.

Ont., Toronto—Toronto Hydro-Electric System, 225 Yonge St., is having plans prepared for the construction of a sub-station at Blythwood Rd. and Yonge St. Estimated cost $1,250,000. P. E. Hart, 12 Adelaide St. E., is engineer.

Ont., Windsor—Detroit & Canada Tunnel Co., 527 Majestic Bldg., Detroit, Mich., awarded sub-contracts for the superstructure of a ventilation building for Windsor-Detroit Vehicular tunnel on London St., here, to G. H. Emery Construction Co., Dowler Bldg., Windsor. Estimated cost $100,000.

Equipment Wanted

Alternator—New York, N. Y.—Dept. of Hospitals, E. F. Cadley, Acting Comr., Municipal Bldg., rejected bids for a 2,300 v., 300 kw. 3 ph. alternator to supply additional current for light, heat and power, for Sea View Hospital and New York City Farm Colony at Castleton Corners, Staten Island.

Boilers—New Albany, Ind.—Anders Rasmussen & Son, Vincennes St., plans to purchases a 400 hp. boiler for heating unit for proposed greenhouses.

Engine, Motor, Pumps, etc.—Star City, Ark.—Waterworks Improvement Dist. No. 3, plans to purchase a 10 hp. Diesel engine, 10 hp. electric motor and two 250 g.p.m. centrifugal pumps for proposed waterworks improvements.

Generator and Engine—Central Islip, N. Y.—Dept. of Mental Hygiene, Albany, will receive bids until Feb. 5 for an electric generator and engine at Central Islip State Hospital, here.

Generator and Engine—Utica, N. Y.—Dept. of Mental Hygiene, Albany, will receive bids until Feb. 19 for an electric generator and engine for Utica State Hospital, here.

Pump—Topeka, Kan.—City will soon receive bids for a motor driven turbine pump, etc., for proposed waterworks.

Pump and Motor—Monrovia, Calif.—City Council, will receive bids until Feb. 3 for a 2,700 g.p.m. horizontal booster pump against total head of 260 ft. and 250 hp. 4 pole horizontal motor.

Pump and Motor—Anancortes, Wash.—City plans the installation of 3 m.g.p.d. pump and motor for proposed waterworks system. Estimated cost $300,000.

Pumping Units—Brooklyn, N. Y.—Dept. of Water Supply, Gas & Electricity, J. J. Dietz, Comr., Municipal Bldg., New York, will receive bids until Feb. 4 for the installation of four 25 m.g.p.d. electrically driven centrifugal pumping units in Ridgewood North Side Station, here.

Pumps and Electrical Equipment—Thermopolis, Wyo.—City, C. W. Gibson, Clk., will receive bids until Feb. 5 for three or more deep well turbine pumps with switchboard, electrical equipment, etc., for proposed waterworks.

Pumps, Motors, etc. — Washington, D. C. — A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Feb. 4, for electric centrifugal pumps, electric motors, boilers, etc.

Pumps — Fort Howard, Md. — Constructing Quartermaster, will readvertise for new bids soon for hydraulic and centrifugal pumps.

Refrigerating Plant—Pearl Harbor—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Feb. 26 for refrigerating plant at Naval Operating Base (Air Station) here. Specification No. 6005.

Industrial Projects

Calif., Los Angeles—Audio Vision Appliance Co., 1016 Sycamore St., awarded contract for the construction of a 2 story, 60 x 150 ft. factory at 1012 North Sycamore Ave. to The Austin Co., 777 East Washington St. Estimated cost $60,000.

Calif., Los Angeles—Crane Co., 321 East 32nd St., awarded contract for first unit of factory, 1 story, 80 x 400 ft. for the manufacture of heavy plumbing supplies and materials to H. Nichols, 936 East Slauson St.

Mich., Detroit—The Michigan Tool Co., O. Lundell, Pres., 147 Joseph Campau St., awarded contract for a 1 and 2 story, 190 x 260 ft. factory to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $300,000.

N. J., Harrison—Driver-Harris Co., Middlesex St., will receive bids about Feb. 15 for a 1 and 2 story addition to factory for the manufacture of alloys for electrical resistance and castings for annealing, carbonizing, hardening and tempering. Estimated cost $250,000. J. A. Finegan, 776 Broad St., Newark, is architect.

N. Y., Oswego—St. Regis Paper Co., Watertown, plans a 60 x 100 ft. addition to paper factory here.

O., Massillon—Tyson Roller Bearing Co., C. E. Stuart, Pres., plans the construction of a 1 story factory at Columbia Heights. Estimated cost $100,000. Private plans.

Pa., Philadelphia—McCloskey Varnish Co., 30th and Locust Sts., awarded contract for the construction of a 1 and 2 story, 82 x 229 ft. factory and warehouse at State Rd. and Rhawn Sts., to F. V. Warren Co., 1913 Arch St.

Pa., Ambridge — National Electric Products Co., 14th St., plans the construction of a 1 story, 25 x 175 ft. factory. Estimated cost including equipment $100,000.

Pa., New Britain—W. P. Cameron Engineering Co., 3850 Marcher St., Philadelphia, Engr., will receive bids until Jan. 30 for the construction of a 1 story, 105 x 115 ft. hosiery mill, 50 x 50 ft. dye plant and 40 x 44 ft. power plant here, for Victor Silk Hosiery Co., Willow Grove.

Pa., Midland—Mackintosh Hemphill Co., 12th and Etna Sts., Pittsburgh, manufacturers of rolling mill equipment and other heavy machinery, plans extensions and improvements to plant including the installation of electric furnace and other equipment here. Estimated cost $85,000.

W. Va., Wellsburg—Harvey Paper Mills Co., W. H. Perry, Pres., awarded contract for a 1 story, 94 x 240 ft. paper bag factory, to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $150,000.

Ont., Toronto—Sun Oil Co., Ltd., 25 Atlantic Ave., will receive bids until Feb. 1 for the construction of a warehouse and other buildings in connection with oil refinery. Estimated cost $200,000. Private plans.